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Barry C. Knight

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THE ORTHODONTIC PROBLEM

By **W. TREVOR JOHNSON**, L.D.S. R.C.S. (Eng.)

In his address last year, Mr. Pilbeam gave us an excellent survey on the possibilities of providing orthodontic treatment for a large number of children, and to-night I want to go a step further and discuss, "How much and what sort of orthodontics should be practised?" The demand is likely to increase over the next few years and add further to the difficulties of providing treatment for all. A first thought might be:—

> "Can the amount of treatment demanded be reduced by preventing the development of malocclusion or by starting treatment earlier?"

To consider prevention we must look back to aetiology and recall that the development of malocclusion, like general development and growth, is very largely influenced by the interaction of two separate sets of factors, the heredity factors and the environment factors. The heredity factors are the genes, the particles transmitted by the parents, and the environment factors, every physical and chemical contact which the organism encounters in prenatal and postnatal life. There is in the first cell a plan already determined for the ultimate size, shape, and relationship of all characteristics known to be inherited, and for this plan to be fulfilled a certain basic contribution from environment must be forthcoming. This consists largely in function, warmth, nutrition, and certain chemical salts.

It is thought that with the greatly increased attention given in recent years to Infant Welfare, deficiencies under this heading are unlikely, and that we should look to the genetic side for the dominant. An ill assortment of genes seems a likely factor. Doctor Wallis told us in his recent paper that we are now keeping alive children suffering from deficiencies from which in days gone by they would have died, and so they too are circulating deficiencies and disturbing influences. There is as yet no means of measuring just how much heredity and environment respectively have contributed in a particular case and it may well be that in practice we shall not go far wrong if, as a general rule, we accept the condition of malocclusion as displayed to be the outcome of normal physiological processes in the individual unless there is recognizable evidence that harmful environmental influences have played a part. In support of this there is the belief that just as there are genes which refer to growth and development, so there are others concerned with the degree of change in pattern which will be tolerated by the organism; and that nature is in itself very resistant to change by environmental influences.

If we accept this theory, we can for the purpose of our discussion divide malocclusion into three groups; types genetically conditioned; types conditioned by harmful environmental influences; and those in which both these sets of factors have played a part. To save time, we shall discuss only the first two groups, although, of course, the third group, a combination of the two, is undoubtedly the largest.

Possibly, the three most common forms of malocclusion accepted as genetic in origin are:—

Deviations from the normal in relationship of the arches anteroposteriorly.

Disharmony in size of teeth and arches, which for brevity we shall call "small arches".

Close bite.

These conditions of malocclusion cannot generally be recognized before the eruption of the deciduous teeth (except in the rare condition of micromandibular development) and so cannot be prevented from developing.

I can call to mind perhaps six Class II, division 1 cases which were treated between four-and-a-half and six years by intermaxillary traction and elastics or by a monobloc, but I found no ready response to suggest that they are better treated so early. When a change in relationship of the arches is sought, intermaxillary traction with elastics is

Presidential address given at the meeting held on January 11, 1954.

preferred and the best time to commence treatment is found to be after the first permanent molars and permanent incisors have erupted. Change in relationship of the arches is more readily induced before 10 than after 12 years of age.

Another advantage in commencing treatment whilst E|E have some expectation of life is that these teeth can be used for anchor bands. The molar anchorage can then be reinforced by a length of wire welded to the anchor bands, gingivally to the buccal tubes, and carried distally to rest in the buccal or distal groove on the occlusal surface of the first permanent molars. This prevents the labial arch from falling incisally, as it is inclined to do, when intermaxillary elastics are used. When 6|6 are banded and 7|7 have not erupted to permit this reinforcement of anchorage being used, it is generally necessary to band 1|1 and weld on to these bands a flat shelf labially for the arch to rest on. The arch is not fixed to 1|1 but just rests on the shelf and is tied in by a ligature from the loop forming part of the stop, medial to the buccal tube, or to the buccal tube itself.

In regard to the Class II, division 2 type of malocclusion, I remember a girl of $9\frac{1}{2}$ years of age, with 21|12 steeply inclined lingually, a severe close bite, and a full-cusp postnormality. This condition was very unsatisfactory indeed and I was tempted to try treatment of the similar condition in her young brother at the age of 5 years. I used for his treatment a plate with an inclined plane and springs to move the anterior segment labially, but again response did not justify such early treatment. In the ordinary way, Class II, division 2 cases are treated at the same stage of development as division 1. Possibly two upper premolars are extracted in the course of treatment more often than in division 1 cases, particularly if the postnormality approaches a full cusp or more. By doing so, the period of treatment is shortened. The line of treatment is the extraction of C|C, movement of 2|2 distally and 1|1 labially by a plate. Provision may also be made for the flattening of the Curve of Spee by depressing the lower incisors, and to widen very slightly the upper arch, if change in relationship of the arches is called for. If the postnormality is postural in character, a forward movement of the mandible as a whole may occur, spontaneously, or with assistance of the inclined plane, but in my experience only a small proportion of cases respond in this way, and intermaxillary traction with elastics is usually necessary to change the relationship of the arches after the plate treatment is completed.

In both Class II, division 1 and division 2 cases a modified monobloc is fitted to serve as a retainer and to encourage improved behaviour of the orofacial musculature. I do not use the monobloc as an active appliance to correct error in arch relationship as the response is uncertain in my hands. It is probable that my lack of confidence in this appliance is the reason for my non-success.

There are still three types which are included in the three conditions of malocclusion which we selected as genetic in origin which have still to be discussed. These are true Class III, small arches, and close bite, and I would say that these cannot be prevented from developing and cannot be improved by treatment with appliances beyond the amount which would naturally take place without appliances excepting, perhaps, the true Class III condition treated very early. In the very early years, chin and occipital traction and a simple plate to unlock the bite are so easily fitted that the opportunity of using this form of traction should not be missed as the patient is then at an age when the parent is more likely to help by insisting on the continued use of appliances day and night. I have seen a number of apparently true Class III conditions between 3 and 7 years successfully treated in this way, but in others, at 10 years and upwards, there is the suspicion that when we do succeed, the degree of improvement is in direct proportion to the amount a postural prenormality has contributed to the deformity. In older children with prenormal occlusion solely genetic in origin, improvement is limited to what can be accomplished by changing the inclination of the upper and lower incisors—inclining the uppers more labially and the lowers more

lingually, but unless a satisfactory vertical overbite of the upper incisors in their new positions over the lower incisors is established, relapse is inevitable. Permanent retention by a plate worn at night is possibly justifiable in some such circumstances.

In regard to small arches, one must suspect the atypical swallow as being a possible powerful influencing factor in development, but in the absence of further evidence it can only rank as a contributing factor, and not as the dominant, as the atypical swallow is found in children with arches of normal size. In any event, the atypical swallow, too, is an inherited characteristic and it would seem that we cannot cure it at will.

I would summarize my observations so far, as follows—In the three forms of malocclusion accepted as genetic in origin we might say:—

1. The malocclusion cannot be prevented from developing.

2. Only Class III cases are treated in the deciduous dentition stage and treatment should be commenced as early as possible.

3. Class II, division 1 and 2 cases are best treated when the permanent incisors and the first permanent molars have erupted, and if a change in relationship of the arches is sought this is best achieved by intermaxillary traction with elastics.

4. The enlargement of small arches is not advised in ordinary circumstances as no enlargement greater than that which will naturally take place will be maintained.

5. A close bite, genetic in origin, cannot be improved by appliances when the relationship of arches is normal anteroposteriorly.

We have now to discuss the malocclusions associated with environmental influences in the light of the question which I posed at the beginning of the paper. I intend to confine my remarks to the two following environmental factors:—

a. The migration of teeth following caries in, or premature loss of, deciduous canines and deciduous molars.

b. The disturbances arising from pressure habits associated with finger, lips, and tongue.

Abnormal migration of teeth can be prevented in the first place by early detection of caries and treatment by well executed fillings, or, if this is not achieved, by the use of space retainers before space is lost. The differences in mediodistal diameter of the deciduous canines and molars and their successors may be no more than 1·0 to 1·5 mm. and therefore caries alone can lead to insufficient space being maintained. Collapse of arches with loss of space is an ever-present factor in the incidence of malocclusion. Frequently it seems to be the dominant factor concerned, and equally frequently it increases the degree of a malocclusion already established, making treatment more difficult and the final result less satisfactory. I will confine my observations to loss of space in the lower only. It is coincident with a medial inclination of the lower first permanent molar and a distal inclination of the deciduous canines and a lingual inclination of the incisors. It is improbable that any change in position of the apices of the affected teeth takes place. My impression is that in the majority of cases the lingual and distal inclinations in the anterior segment make the greater contribution to the loss of space. It is to be noted that individuals react differently in the degree of disturbance which takes place. This cannot be explained either by differences in the age at which the extraction occurs or by differences in size of arches. Lip behaviour is a likely contributing factor and Sheldon Friel has stated that the normal medial migration of the teeth medial to the extracted tooth is less likely to be slowed up in jaws of vigorous growth and that, in such circumstances, if space is lost, it is more likely to be regained spontaneously. Or it may be an example of a variation in degree of genetic resistance or tolerance to environmental change. Sometimes a lower first permanent molar will display an unusually steep medial inclination which alone is sufficient to account for several millimetres of lost space. This may be due to a greater than average difference in growth potential in the alveolar and basal bone areas, which is only recognized when space in the arch from an extraction or caries occurs. The intra-oral film, as we generally take it, gives us a very poor idea of these inclinations. It would help if they could be related to the mandibular plane,

Fig. 1.—Male at 9 yr. 11 mth. and 11 yr. 6 mth. Classified as Angle Class I, with tendency to Class II, particularly on the left. An X-ray showed apices of $\underline{3|3}$ to be not unfavourably placed for treatment by extraction of $\underline{2|2}$. The inclination of $\underline{3|3}$ is more accurately shown on an extra-oral film. $\frac{2|2}{|1}$ were extracted and a lower plate fitted to maintain size of lower arch until the canines and premolars were on their way to complete eruption. A spring was included to move $\overline{|2}$ labially. The alinement of the incisors and the occlusion is very satisfactory. The plate was worn at night only after the first three months.

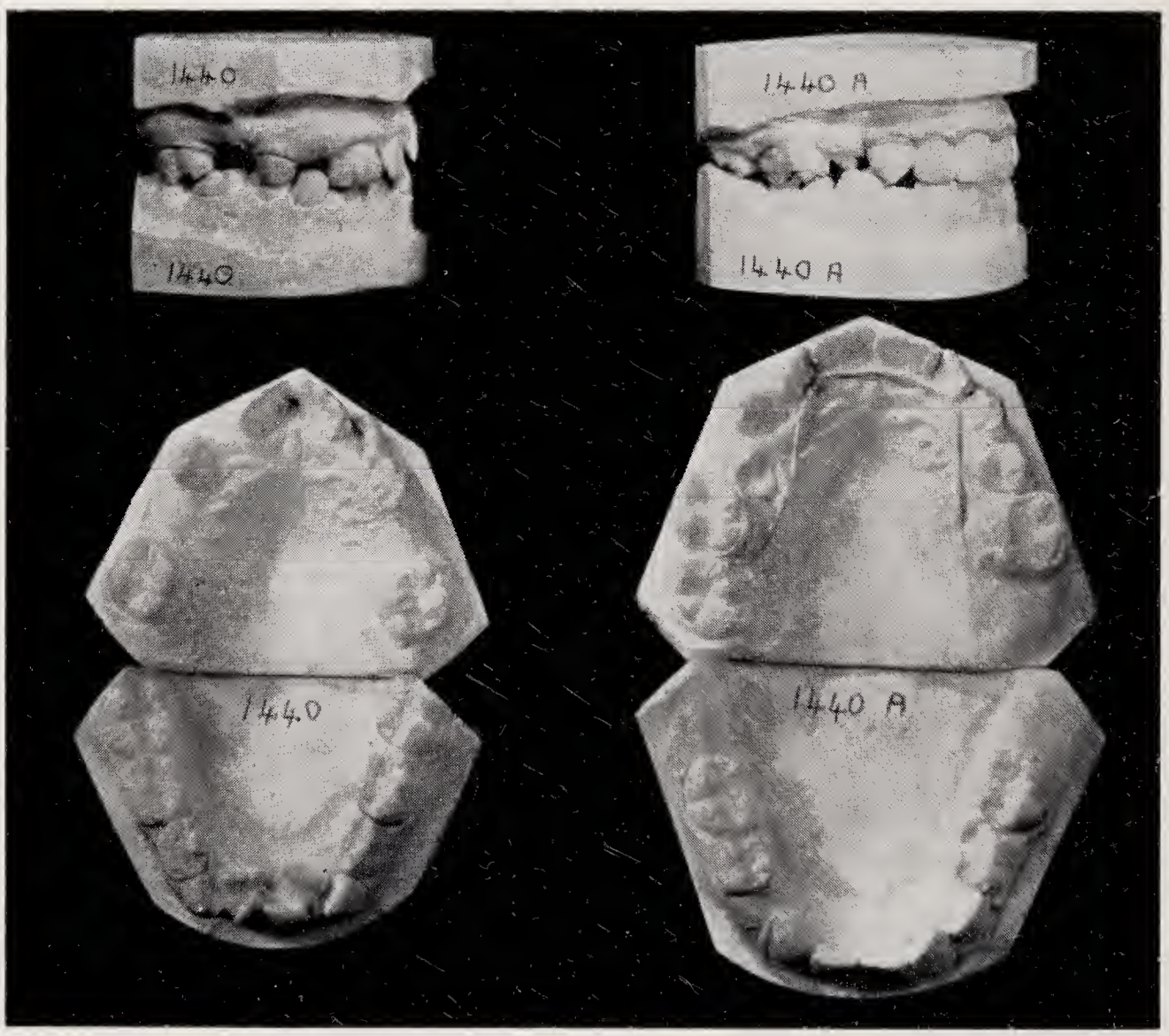

Fig. 2.—Female at 9 yr. 5 mth. and 12 yr. Angle Class I. Arches are small and teeth large. Space has been lost in upper. $\overline{1|1}$ were extracted and a plate fitted to move $\overline{2|2}$ labially. $\underline{4|4}$ were extracted on eruption. There was always a deficiency in space for $\underline{532|}$. With $\underline{7|}$ erupted it will not be possible to find room for $\underline{5|}$ without increasing the incisor imbrication. This would have been better done much earlier.

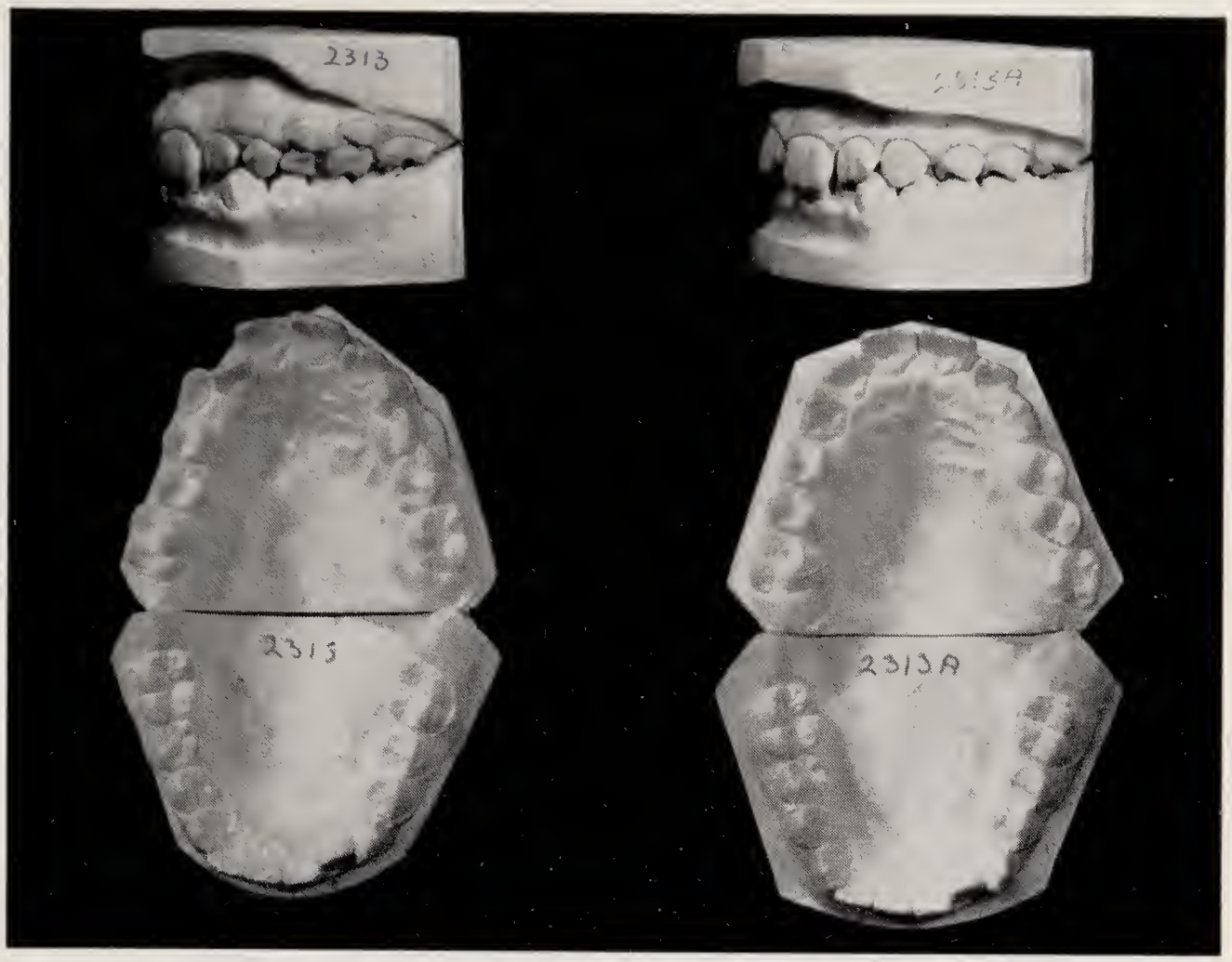

Fig. 3.—Female at 9 yr. 9 mth. and 10 yr. 6 mth. Angle Class I. $\underline{6|6}$ extensively carious. Treatment: $\underline{6|6}$ extracted and plate fitted to move $\underline{54|}$ distally by a screw and $2|$ labially by a spring. In the first models it will be seen that $\underline{|45}$ are erupting high up buccally. $\underline{|DE}$ were extracted and they erupted in alinement, but rotated.

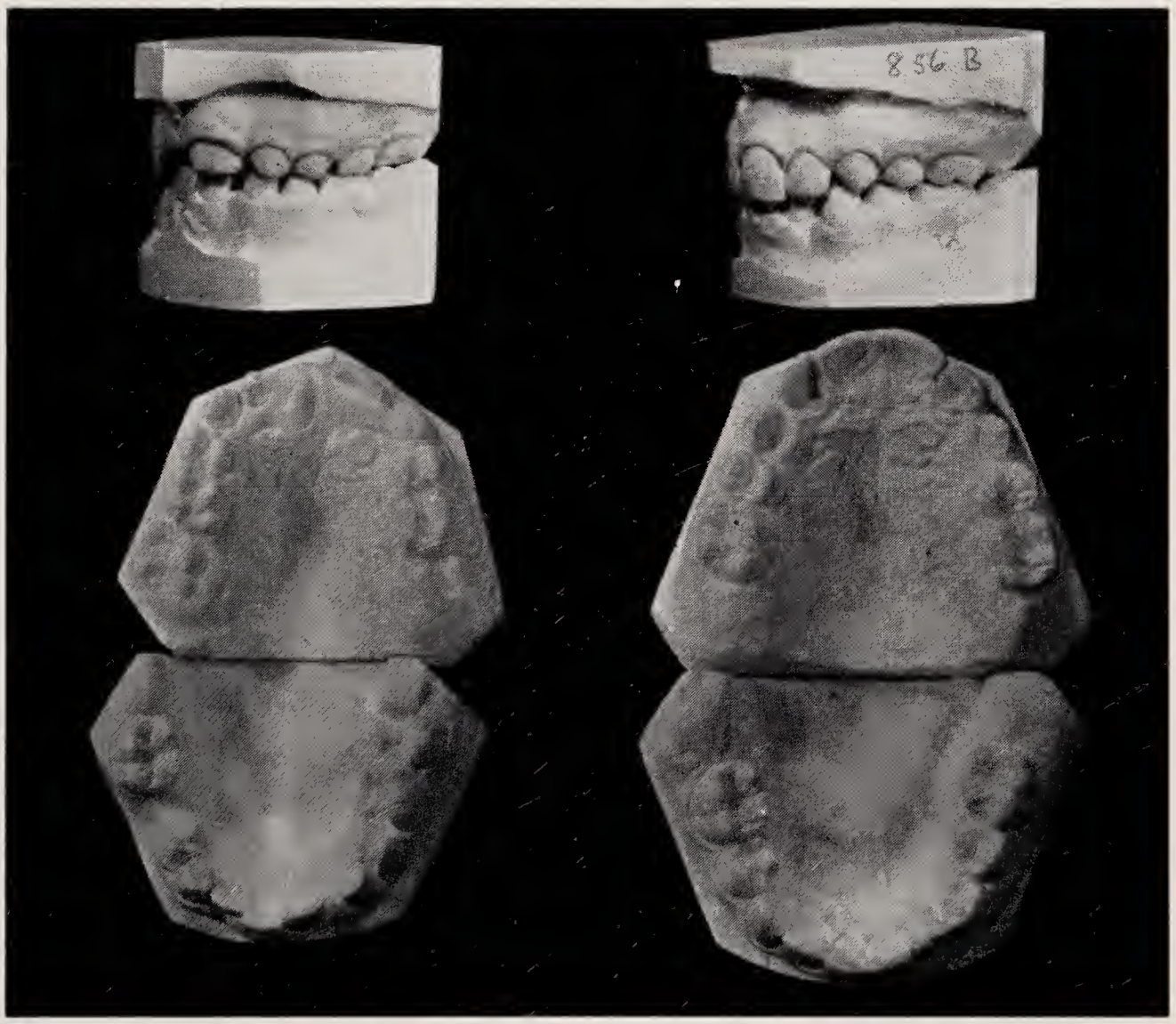

Fig. 4.—Female at 7 yr. and 11 yr. 2 mth. The supernumerary was extracted before treatment. Classification difficult. Probably Angle Class I. Space lost in all four buccal segments from caries or premature loss. The arches are small and the teeth large. Treatment: $\overline{|CDE}$ extracted and plate fitted with spring to move $\overline{|2}$ labially on eruption, and to prevent collapse of arch. $\frac{4|4}{4|4}$ were extracted on eruption. The occlusion and alinement of teeth is good. In most cases when the choice lies between a canine and premolar the latter will give a better result. In this instance $\overline{|3}$ was shut out completely with the apex well medially.

but I have not yet found a way of doing this accurately with an intra-oral film.

I have very little to say about pressure habits and shall only touch on finger sucking. My general approach to the cure of it is to persuade the child that the whole trouble is that they cannot resist the urge just as they are falling off to sleep and that in order to remind them that they want to stop the habit they are to get their mother to sew on to the end of their pyjama sleeves a good-sized bag of material of a thickness of, say, sheet material. If they enjoy sucking this, they are to double the thickness and if this still fails, a large piece of carpet is to be added. I have not heard of the carpet being used yet, but the children seem to like this line of treatment and I have found it successful in a large proportion of cases. The degree of disturbance is variable and the open bite tends to improve when the habit is broken. The rate of improvement is often slower in a child of 9 and over and, in some cases, it seems to be unlikely that the upper and lower incisors will make contact. The tongue thrust is a complication, but I am inclined to think that, except with an over-sized tongue, natural vertical growth will, in the end, overcome any influence the tongue thrust offers, unless there is a genetic open bite tendency also operating.

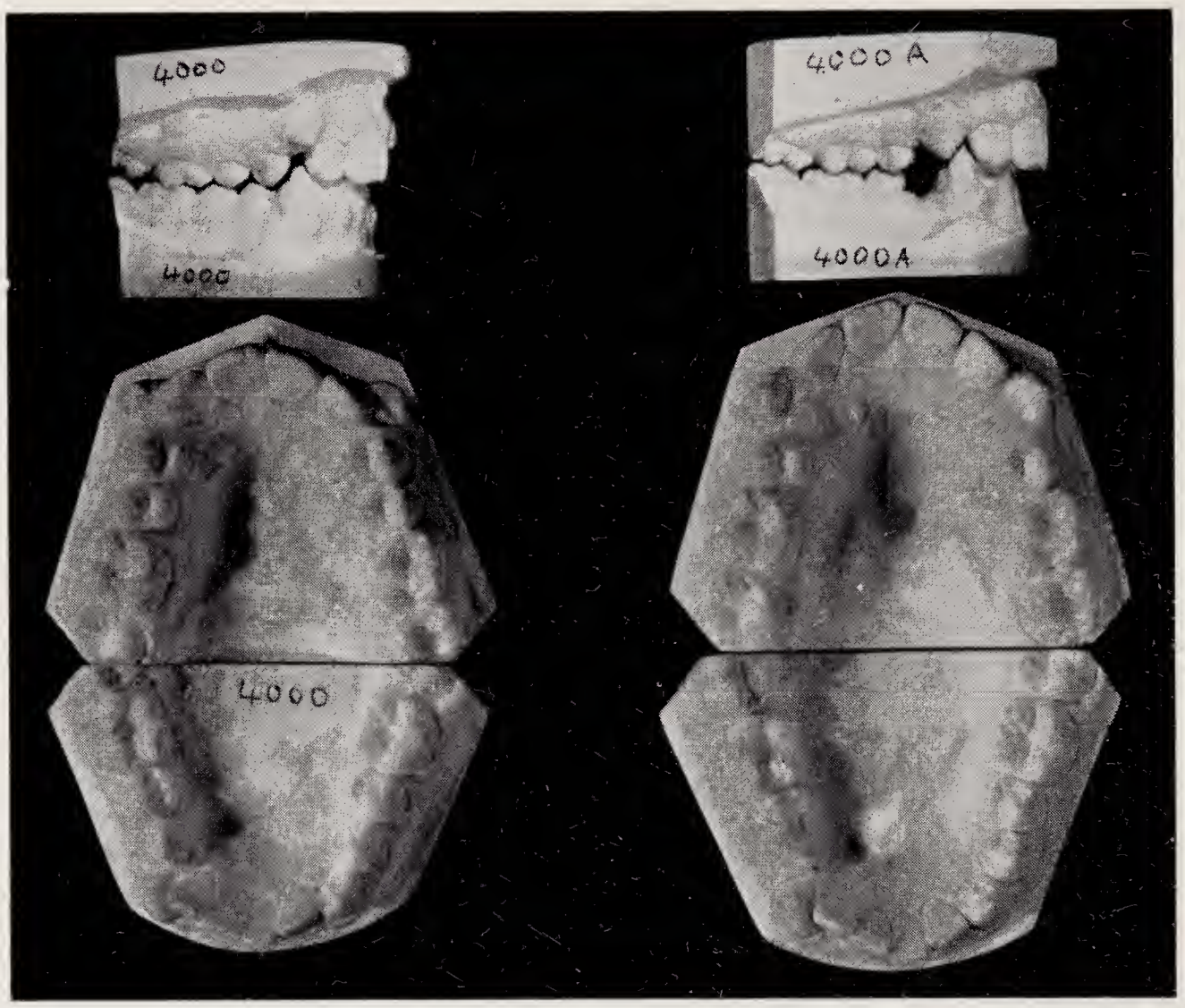

Fig. 5.—Male at 10 yr. 6 mth. and 11 yr. This case is of interest as the advice given this parent by two orthodontists differed completely.

The occlusion is a full cusp post-normal bilaterally $\frac{3|3}{3|}$ are *shut* out of the arch. The arches are small and the bite close, but the lower incisors meet the neck of the upper incisors, and are not in contact with the *mucosa*. The patient is still wearing appliances.

The first opinion was influenced by the wish of the parent and the referring dentist that extractions be avoided. A long course of treatment was advised. The second opinion was that $\frac{4|4}{4|}$ be extracted and plates used to move $\frac{3|3}{3|}$ into the line of the arches. The second treatment will produce good alinement of teeth and occlusion, and it would not be possible permanently to correct the irregularity without extractions. As two units have been removed in the upper and only one in the lower, it is thought that the close bite will with natural development be reduced rather than increased.

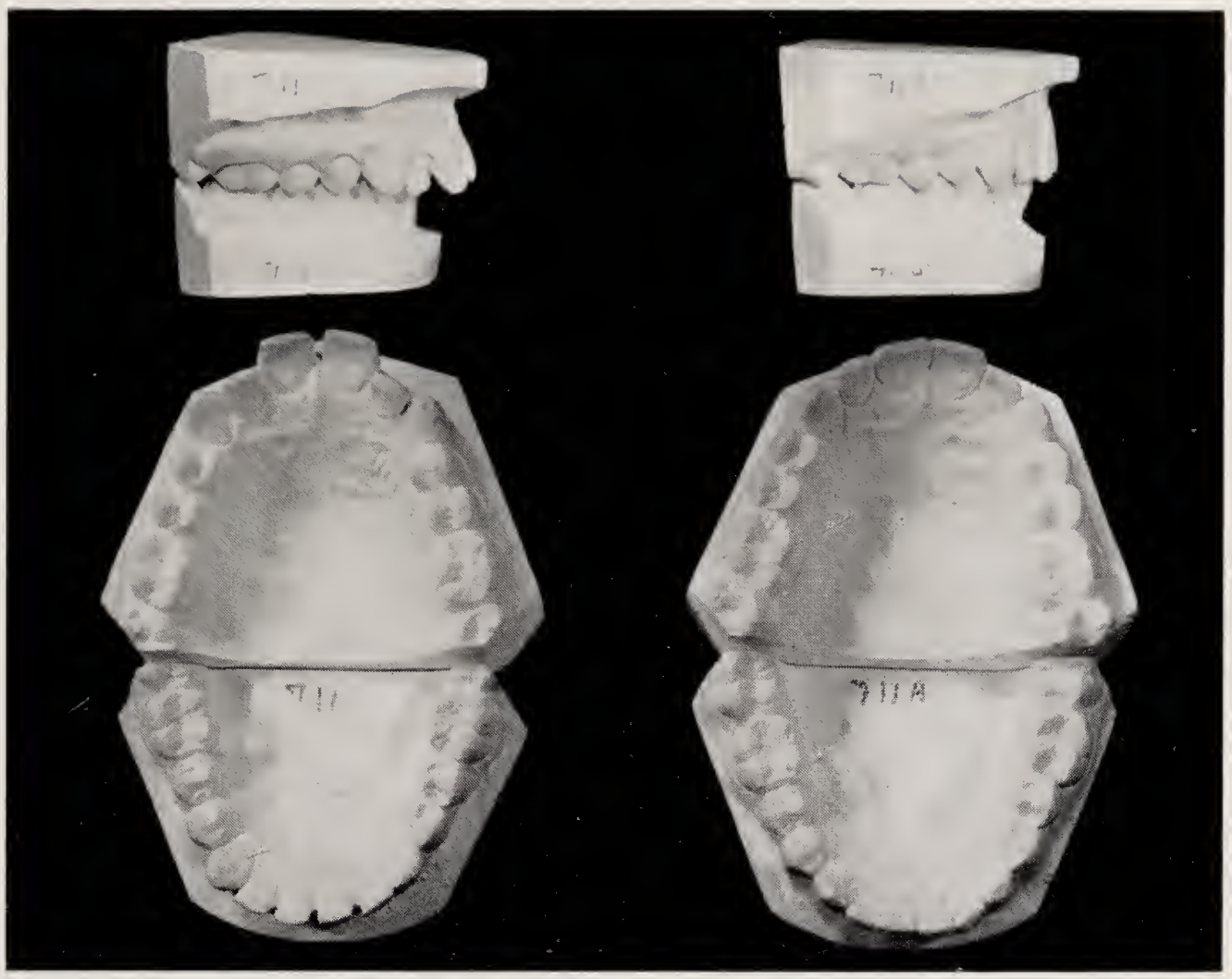

Fig. 6.—Male at 13 yr. and 16 yr. 2 mth. Angle Class II, div. 1. The post-normality is a full cusp and bilateral. There is a close bite and marked inclination of the upper and lower incisors. The patient's tongue is very long.

Treatment: By fixed appliances, firstly with reverse intermaxillary traction to close the lower incisor gaps by moving them lingually, and secondly with Class II elastics to change the relationship of the arches and move the upper incisors lingually. The lower incisors were very inclined to space again immediately, and very stern measures were necessary to prevent this until correct relationship of the arches was achieved.

Relapse was feared owing to the tongue, but seen two years after all appliances had been discarded the improvement is still maintained. A monobloc was worn for a year after all fixed appliances were removed.

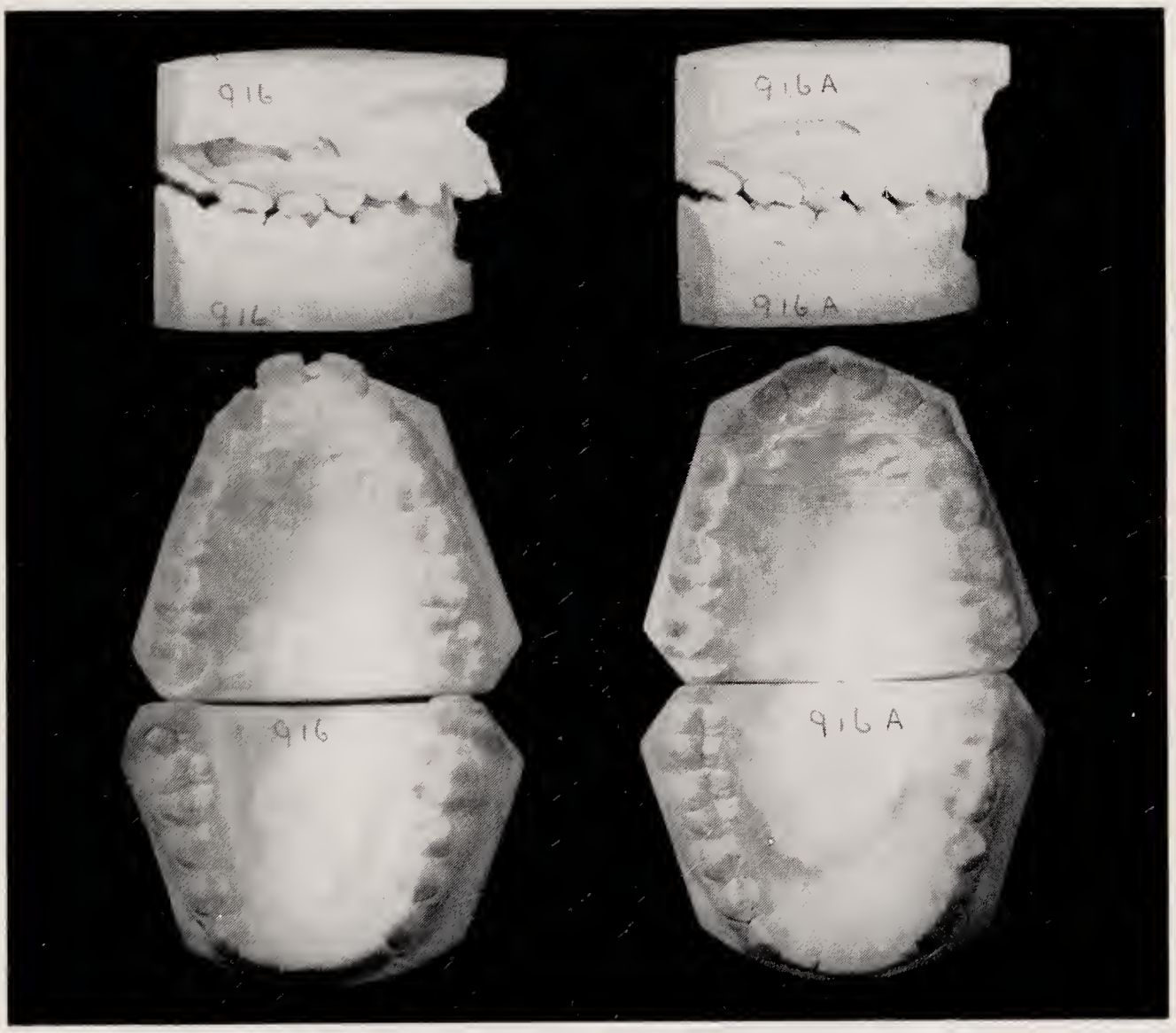

Fig. 7.—Male at 11 yr. and 15 yr. 2 mth. Angle Class II, div. 1.
Treatment: Fixed appliances and Class II elastics. Response was ready and final occlusion almost ideal.

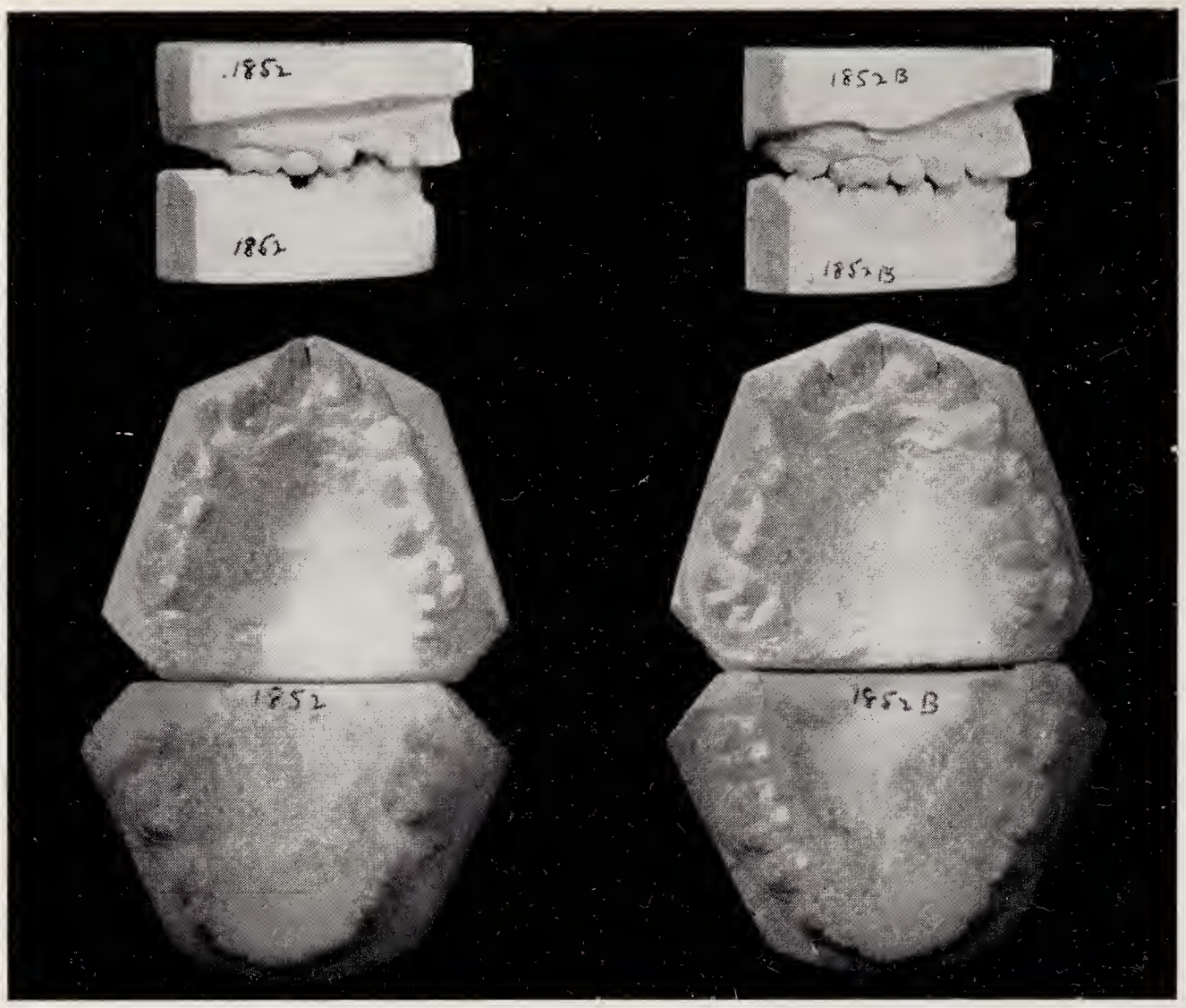

Fig. 8.—Female at 11 yr. and 13 yr. Angle Class II, div. 1. The post-normality is a full cusp and $\overline{21|12}$ bite hard on the mucosa at the necks of the upper incisors. Space lost in lower is more than can be regained.

Treatment: Extraction of $\frac{4|4}{4|4}$ and fixed appliances and intermaxillary traction followed by monobloc. No special provision in design of appliance was made to close spaces or rotate the incisors. It is thought that there is still time for the gaps in the upper to close. If four premolars had been extracted and no change in relationship of arches had been induced, no improvement in the close bite would have taken place.

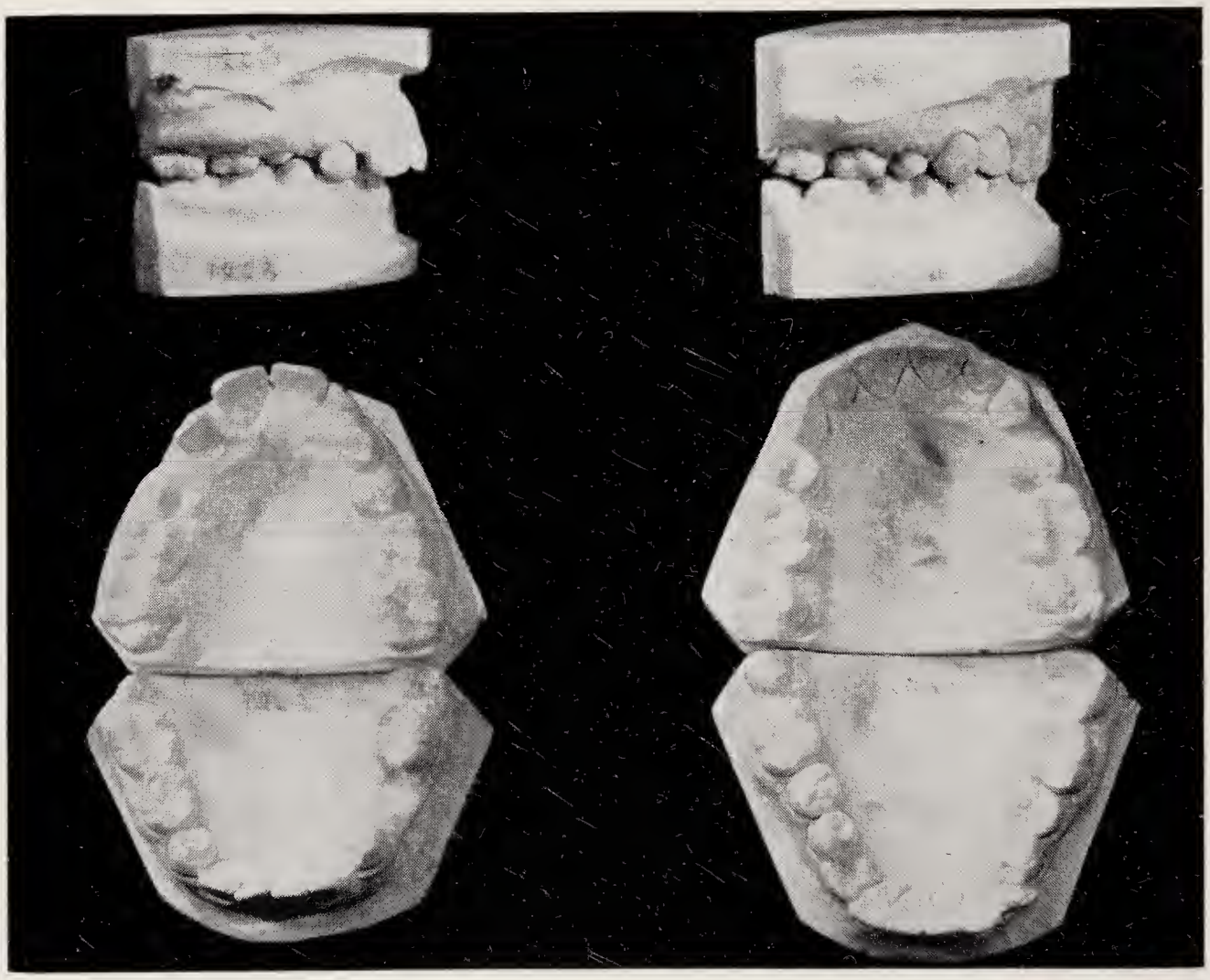

Fig. 9.—Female at 10 yr. 4 mth., and 14 yr. Angle Class II, div. 1. This is a skeletal Class II in which great difficulty has been experienced in getting a result. The lip posture was very unfavourable and great difficulty was experienced in finding room for the lower incisors. Here again a lower central incisor should have been extracted.

Treatment: Two years were spent in gaining space in the lower check teeth areas. Then intermaxillary traction was used for six months to move $\underline{21|12}$ lingually and change the relationship of the arches. As there was no response $\underline{4|4}$ were extracted, $\underline{321|123}$ banded, and $\underline{3|3}$ moved distally with intermaxillary elastics; then $\underline{21|12}$ were moved lingually and a monobloc was fitted.

The upper incisors are not sufficiently labially inclined, but it is possible that no better result than this can be achieved in some skeletal II cases. It is possible that relapse is more likely in this type of case than it is in cases which respond readily to change in relationship of the arches without excessive uprighting of the upper incisors.

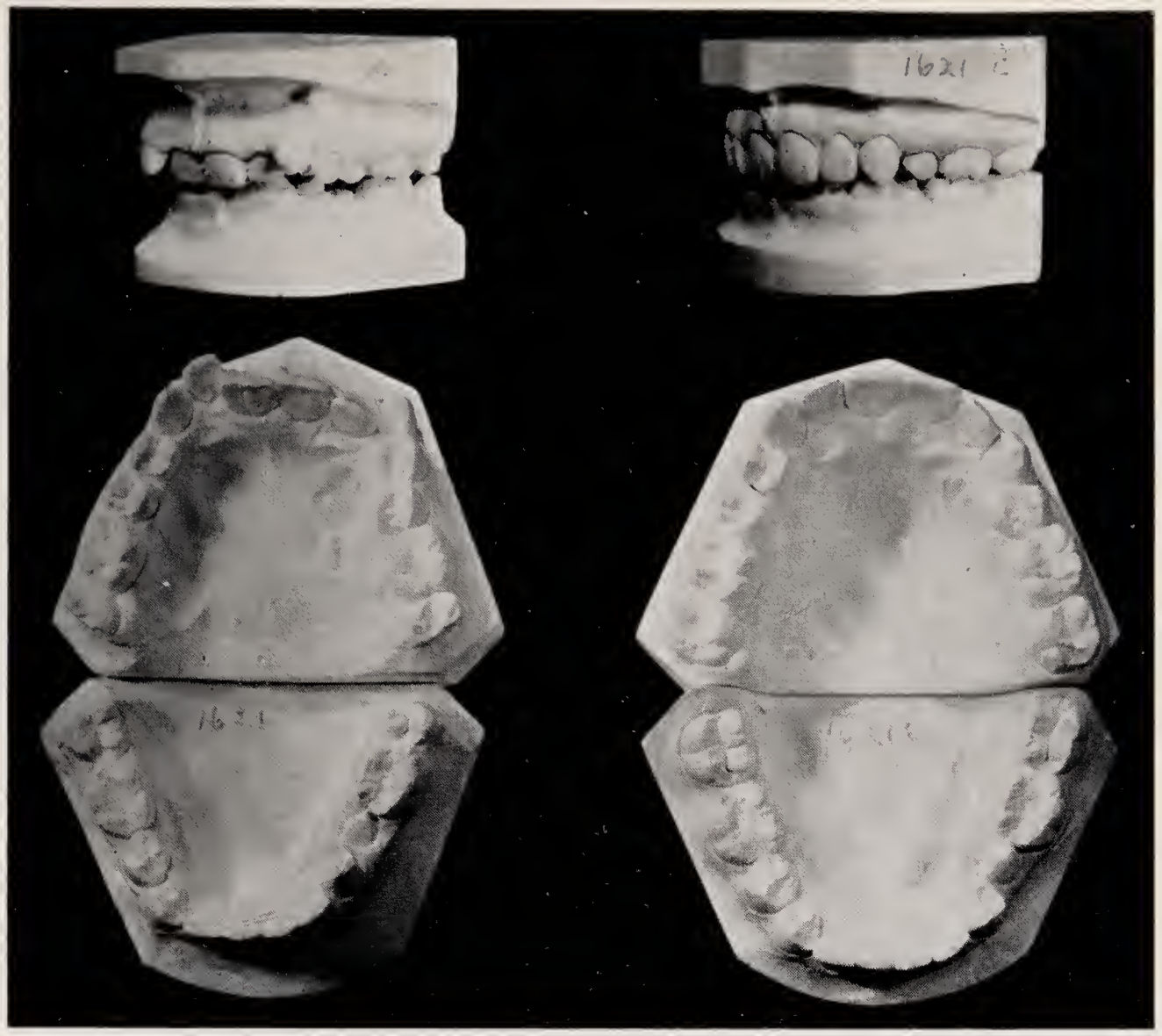

Fig. 10.—Female at 14 yr. 5 mth. and 16 yr. 7 mth. $\underline{3|3}$ were either absent or were extracted. The occlusion is probably nearer normal with a tendency to Class II, div. 2, but the lower arch is collapsed, which gives the appearance of Class II, div. 2.

Treatment: (*a*) Extraction of $\underline{|4}$ and plate fitted to move $\underline{|2}$ distally and then $\underline{1|12}$ labially; (*b*) Lower fixed appliance and an upper plate to carry hoops in the canine region for intermaxillary elastics. The impaction of $\overline{|5}$ is a defect, but by measurement there never was enough room for $\overline{|45}$, and with $\overline{|7}$ erupted it is difficult to increase the space for it.

In a plate of this type the use of the Adams pattern of crib on an incisor has been found to be a very valuable aid in retention. The cusps of the cheek teeth (or perhaps the lingual cusps only) are covered by a thickness of acrylic resin sufficient to protect the cribs, and this opening provides sufficient space to carry the crib over the tips of all incisors. The tips of the incisors are covered to prevent any elongation of the cribbed incisor and when the plate is fitted the acrylic resin covering the teeth is trimmed to give the patient an even bite in function. The patient seems to find no inconvenience from this gagging and if any depression of teeth takes place from the increased height of the bite, this quickly rights itself when the appliance is removed. This crib on an incisor is also very useful for lower plates when cheek teeth are not very suitable, and particularly so for retention plates which the patient is inclined not to push right home. The same precaution of covering the tip of the incisor cribbed is necessary.

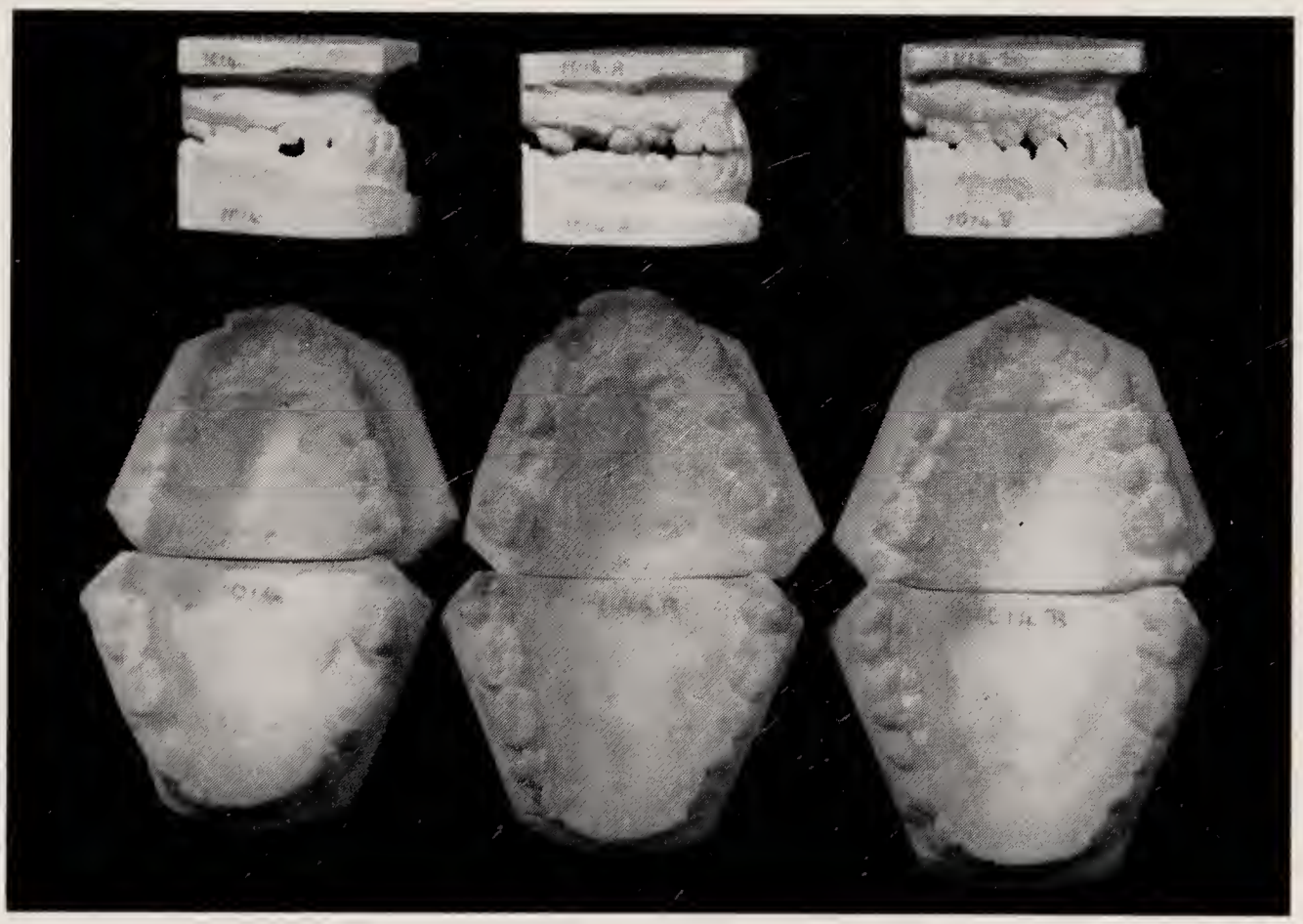

Fig. 11.—Female at 11 yr., 14 yr., and 15 yr. 5 mth. This is an example of a true Class III malocclusion and the relapse which will take place if a vertical over-bite of the upper incisors over the lower incisors does not develop in the course of treatment. Treatment was by fixed appliances and reverse intermaxillary traction.

To summarize observation on the second part of the question, I would say that loss of space in the cheek teeth areas can be prevented by early detection of caries and insertion of fillings. Bite-wing films might be more frequently used in the deciduous dentition period to aid in early detection. Space retainers should be fitted immediately it is seen by obscrvation and measurement that excessive loss of space is taking place, unless it is certain that some extraction will be called for in any event. A plate worn at night is sufficient and a small amount of lost space can be regained if a screw is included. Space lost in the lower leads to disturbance in both jaws, and so this jaw should receive priority in treatment.

Leroy Johnson said that "the purpose of orthodontics is to correct and prevent the occurrence of tooth relations which will interfere with normal development and functional activities of the dental mechanism". This quotation is from his *Basic Principles of Orthodontics*, which, although published in 1923, still remains a very important contribution to orthodontic literature. My impression is that he accepts as the best treatment any arrangement of teeth and arches which will maintain the dental structures and surrounding tissues in good health and contribute to the mental and physical well-being of the individual. I believe our general approach to the problem of treatment to-day is inclining this way and that when a result can be obtained by extraction alone we choose it; and use simple appliances and short treatment whenever it is reasonable to do so. This treatment may not bring a result as good æsthetically, or occlusally, as prolonged treatment would, but it will still be the best treatment unless we are quite sure it will shorten the life of the dentition. Only clinical experience will guide us and sometimes we have to decide that anything short of long treatment with complicated appliances will be a waste of time.

I am reporting a number of cases which either illustrate the points I have raised or introduce somc other item of interest. The final models are, in most cases, recently taken, and not at completion of treatment.

[The President then showed 25 cases. A selection from them is illustrated in *Figs.* 1–11.—*Hon. Ed.*]

In conclusion, I should like to say that the problem of orthodontics is part of the problem of children's dentistry as a whole. The Departments of Conservation, Dental Medicine, Orthodontics, and Periodontology are all equally concerned. If they got together and examined a random sample of the child population of this country, it is certain they would decide that conservation treatment in the deciduous, mixed, and permanent dentitions is the most urgent immediate need.

Finally, I should like to record my thanks for assistance from Mr. A. J. P. Cousins, who has taken quite a big part in treatment of some of these cases, and to the Department of Medical Photography, University of Bristol.

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DISCUSSION

Mr. H. Chapman thanked the President for his lucid address and for his invitation to open the discussion. He had spoken of the aetiological factor, current practice, and his own views on treatment in such an unequivocal manner as to disarm criticism, so remarks bearing on the questions propounded were based on thoughts on cases called to mind by the President's eminently practical paper.

He agreed with the President when he said that Class III cases gave the most satisfactory results, particularly when the treatment was commenced early.

A decision as to extraction in various types of cases seemed to present difficulties at times, whereas this should not be so. Recently he had seen a report of a case where the upper incisors were lingual to the lower incisors, in which two lower premolars were removed from a perfect lower arch. The decision to do this was based on cephalometric findings. He doubted if the extractions were beneficial. Extraction seemed uncalled for, even detrimental, where there was room for all the teeth; sometimes crowding was preferable to extraction.

The effect of habit was transitory. He had seen a considerable open bite, say 5 mm. in the incisor region, change to one of close bite in a year from age 9 yr. 4 mth. to 10 yr. 4 mth. without any treatment except cessation of the habit. Might not the effect of other habits disappear in similar circumstances? The President had referred to the fact that the atypical swallow may be seen in children with arches of normal size, so it seemed that this habit (if such it is) was not necessarily a cause of malocclusion. It was important that the orthodontist should know what was self-correcting, and, also, was aware of those changes associated with normal development which at some stages may be mistaken for abnormalities: he had seen such cases under treatment unnecessarily, sometimes for long periods. One was, except for the effects of thumb-sucking, probably a nice example of normal occlusion which, the habit having ceased, would have resolved itself, but after long treatment was being effectually prevented from doing so by an appliance.

The President had asked two questions: "How much and what sort of orthodontics should be practised?" and "Can the amount of treatment demanded be reduced by preventing the development of malocclusion or by starting treatment earlier?" There was no one answer to these. That a genetic (or congenital) condition could be prevented seemed beyond our powers, but there was probably an optimum time for treatment.

Environmental (and local) causes were in a different category. It should be possible to eliminate these or to counteract them, e.g., habits and premature loss of teeth. One preventive he rated highly in this connexion was the diet advocated by J. Sim Wallace fifty years ago; it developed good masticatory habits and a clean mouth—in the President's words it provided the best physical and chemical contacts. It was regrettable that his teachings, simple and practical, were so rarely referred to; they could be introduced into every home immediately even more readily in these days when fruit was available all the year round. A pamphlet, *Prevention of Caries*, which enumerated his tenets, had been published.

In conclusion Mr. Chapman said that each case must be judged individually. Treatment should consider the future welfare of the dental tissues—i.e., it should be as short and simple as circumstances permitted; he would answer the President's questions thus: The amount of treatment could be reduced by:—

1. Prevention of caries.
2. Prevention of malocclusion as a result of caries and premature loss of teeth.
3. Avoiding unnecessary treatment, e.g., cases in a developmental stage which was not an abnormality, and the apparent irregularity would disappear in the course of time.
4. Avoiding errors of treatment, e.g.: (*a*) cases which would be self-correcting when a habit ceased; (*b*) due to faulty diagnosis, prognosis, or treatment.
5. Treatment at the optimum age, i.e., at the earliest age for the particular case.
6. Simple treatment in preference to prolonged, difficult treatment. (If post-normal occlusion could be corrected in the deciduous dentition and as simply as pre-normal occlusion, that would be a great simplification.)
7. Utmost efficiency of appliances.
8. Not undertaking treatment when the prognosis and other factors were unfavourable.

Finally, Adamson's comment should be remembered, that "preventable malocclusion is being created daily".

Mr. H. G. Watkin said he was glad to hear the President say that he did not generally advise expansion, as no expansion greater

than what would occur naturally would be maintained.

The President spoke of extracting a lower central incisor. Personally he considered it important to avoid extraction of any lower incisors as it might lead to imbrication of the upper incisors later. He considered that the extraction of two units was necessary from the upper jaw to balance the extraction of one lower incisor.

Mr. H. E. Wilson asked if the President had any proof for his statement that atypical swallows were inherited. So far as he knew, this theory had not been proved. He agreed that Class III cases should be treated early, but thought this also applied to Class II, provided that a suitable appliance could be inserted early enough. He knew that it was now believed that treatment could not alter the apical base relationship, but thought this was still in doubt. Ricketts, in America, when working on the relationship of the condyle and fossa before and after Class II treatments, had found that before treatment the condyle was more downwards on the ementia than was normal and moved upwards and backwards when the mandible moved from the resting to the occlusal position, but that after treatment the position and movement was comparable to normal. Ricketts considered that this proved there was no growth of the condyle, but he himself regarded it as proof that there was such growth; and if so, there was every indication for early treatment of Class II cases. In fact the earlier the start, the better the prognosis.

The President said, in answer to Mr. Chapman's question, that in Class II, div. 2, cases there was no reason for moving an upper incisor labially other than the bringing forward of the mandible.

With regard to the extraction of lower incisors, he extracted them in some cases. He thought it would be agreed that if three incisors were straight and the fourth crooked, the fourth could be removed and the space would close and the others remain straight; but if all four incisors were irregular, the removal of one would not as a rule help the rest to straighten. Years ago, one of Colyer's stock treatments was to extract a lower incisor and two upper 4s.

Regarding early treatment of Class II cases, this had not been his practice; but he thought Mr. Wilson may have had more experience than he had had. He did not feel he could help by discussing the subject as he had not read Ricketts' work, but felt sure that members would benefit from Mr. Wilson's remarks.

Mr. P. G. Oliver (Croydon), in proposing a vote of thanks to the President, said that as one of the elder statesmen in orthodontics Mr. Trevor Johnson had shown that he was not afraid of breaking a few rules, and he thought other orthodontists, as they grew older, might tend to do so too. The President had shown that very good results could be obtained by so doing. He agreed that when making a provisional diagnosis and working out a line of treatment, orthodontists should consider the length of treatment as a whole. Children from 11–16 years of age had heavy calls on their time, and he thought that if a 95 per cent rather than a 100 per cent result could be obtained by some reduction in the length of treatment, it was to the good.

THE MORPHOLOGY OF THE LIPS IN RELATION TO THE INCISOR TEETH

A PRELIMINARY REPORT

By **W. A. NICOL**, L.D.S., D.D.O.

Of the factors influencing the position of teeth, much study has been devoted to the morphology of the jaws and their relation one to the other (Broadbent, 1937; Brodie, 1950, 1952; and others). Considerable notice has been taken of the effect of muscles surrounding the teeth, and in particular the way in which they function or fail to function, or have perverted function (Ballard, 1948, 1953; Gwynne Evans, 1948; Rix, 1946). The morphological aspect of the environmental muscles of the teeth has received scant attention.

It has been recognized for some time that a small or large tongue has an influence on the form of the dental arch. The conditions have even acquired the special names of microglossia and macroglossia. The lips and cheeks are also subject to considerable variation. Lightoller (1925–6) describes great variation in the size and form of the muscles forming the lips, and as orthodontists we speak of a patient having a short upper lip, without having a very accurate idea of what consequences this may have.

For the purposes of this short communication it is proposed to look more closely at the effects of variation in lip form on the incisors and, in particular, the relationship which exists between the lip line and the level of the incisor teeth.

The only reference that can be found on the relation of the lip line to the incisor teeth is by A. G. Brodie (1950), who says, "The lip line may vary from the level of the incisal edges of the upper teeth to well above their gingival margins and it thus becomes apparent that it is the lower lip that controls the upper teeth".

The relationship is obviously governed by the inherent morphology of the lips, and the occlusal level of the incisor teeth.

As a result of work carried out by J. R. Thompson (1946) and others, it has been shown that the occlusal level of the upper incisors is controlled by the muscular activity of the muscles of mastication on the mandible

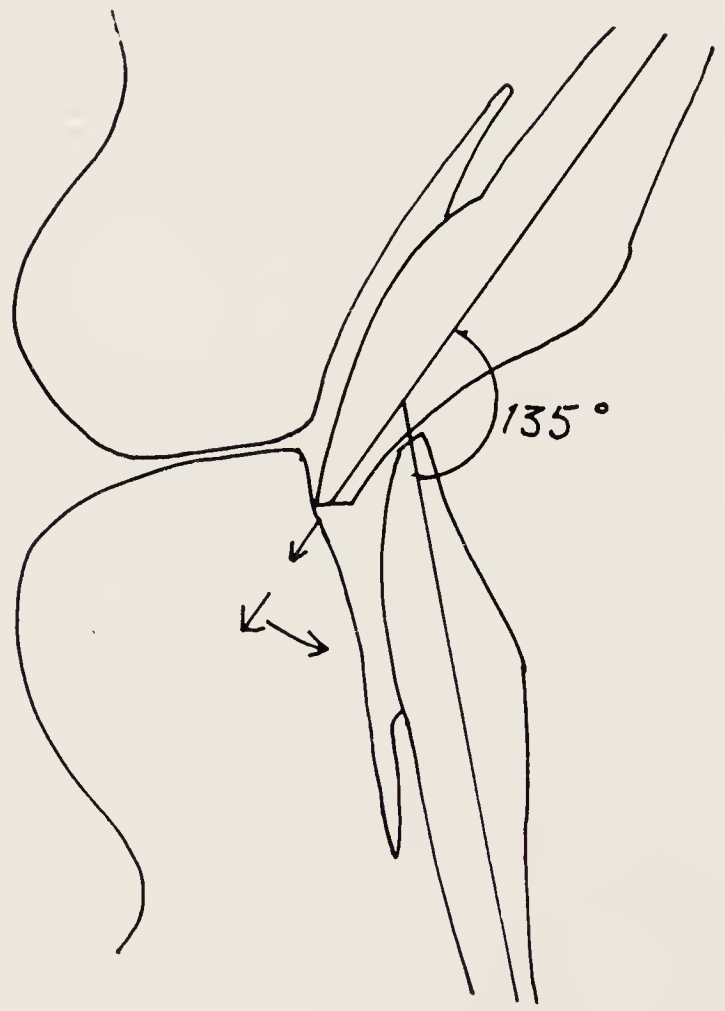
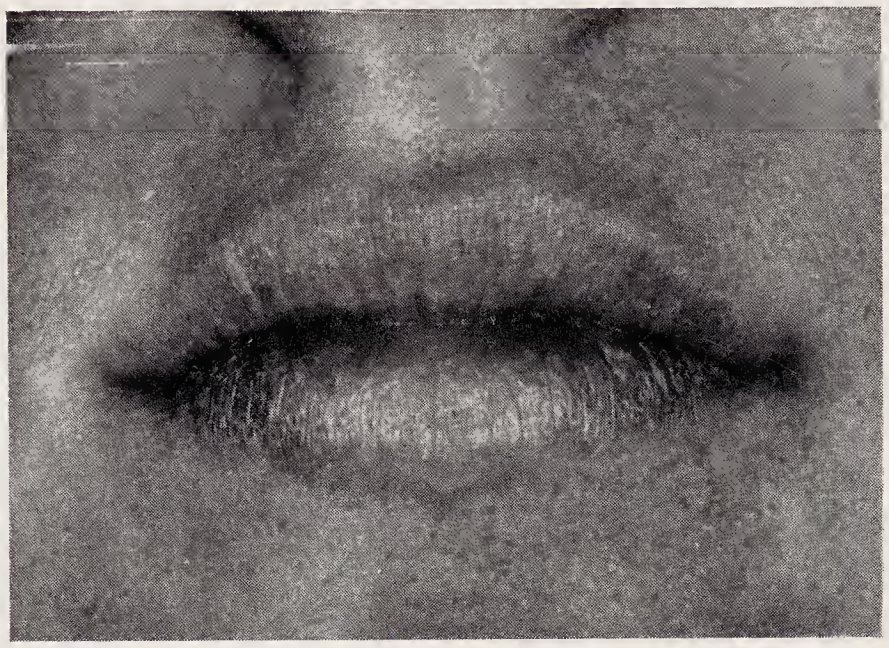


Fig. 1.—Incisors at Down's mean angle of 135° to each other, and lips drawn so that the lower lip just covers the incisal edge of the upper incisor.

together with the normal vertical development of the jaws and normal occlusion of the teeth, upper with lower. Where the occlusion is abnormal, the incisors tend to continue vertical movement accompanied by their supporting structures until stopped—usually by some soft tissue (the lip in the case of upper incisors). When such upper incisors move downward they come under the influence of an altered environment. They come under the control of a greater depth of lower lip. By

Short communication presented at the meeting held on January 11, 1954.

the anatomical shape of the inner surface of the lower lip alone, these incisors tend to be tilted lingually (*Fig.* 1); that is, without any increase in muscular activity and without any change of posture of the lower lip.



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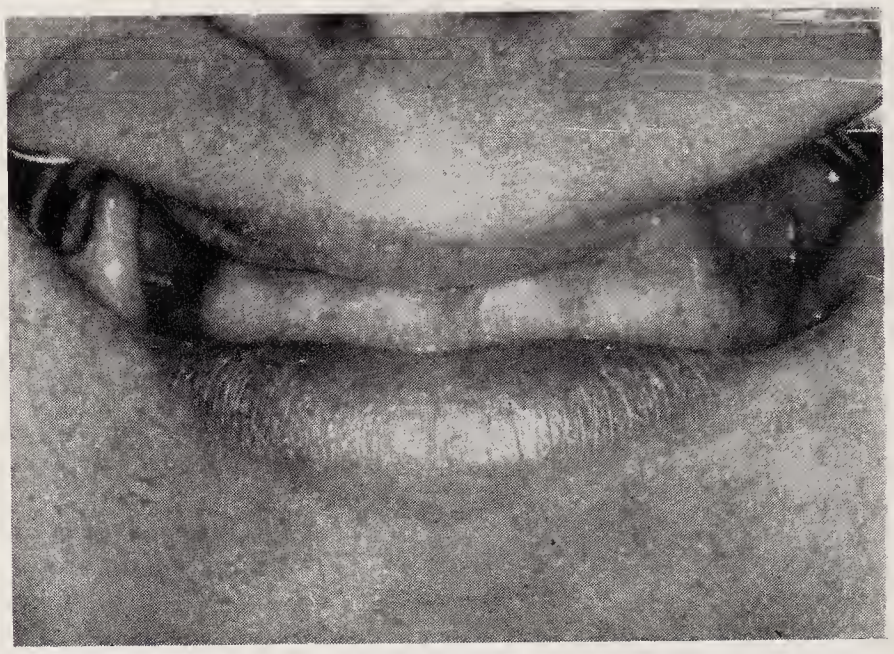


B

C

Fig. 2.—A, Lips in normal resting position. No variation from normal of either morphology or behaviour pattern. B, Upper lip lifted aside to show how lower lip covers the whole labial surface of the upper incisors. C, The same case showing deep overbite and imbrication of upper incisors.

This effect on upper incisors may be brought about where there is a short upper lip and the upper incisors are at a normal vertical height. They will be tilted lingually by the lower lip.

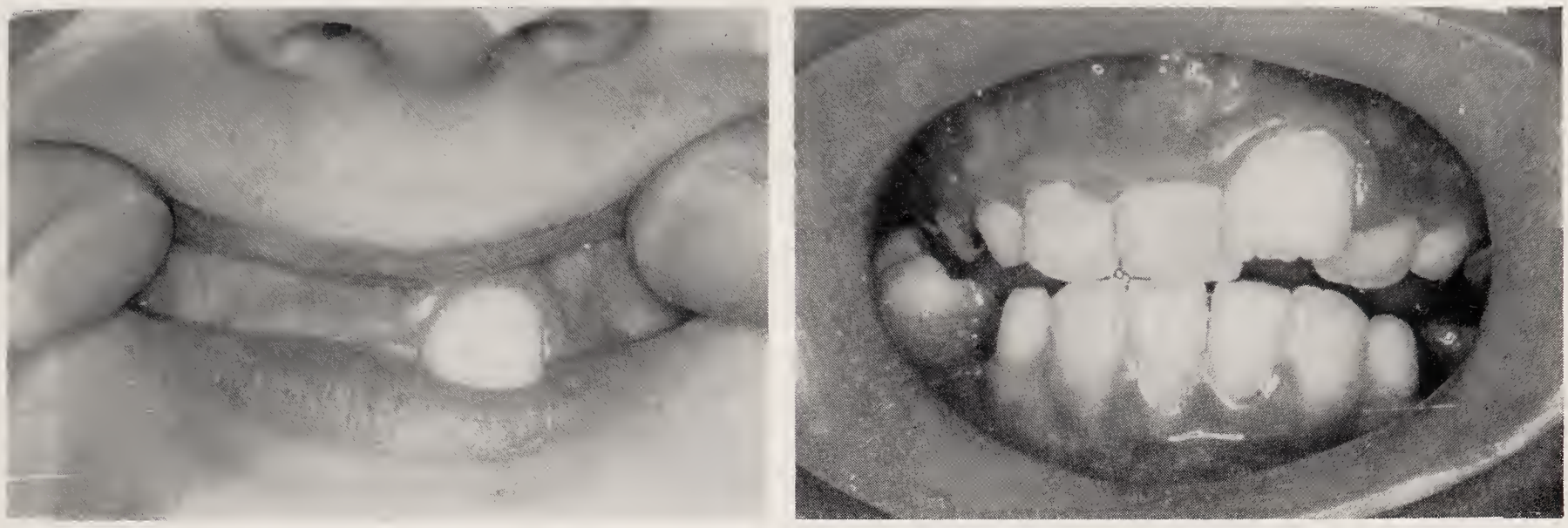
A study has been made of the relative position of the lip line in 16 cases of deep incisor overbite. In no case did the lower lip cover less than half of the labial surfaces of the clinical crowns of the upper incisors, and in several cases it covered all of the labial surfaces of the upper incisors (*Fig.* 2, A, B, C). In two cases of deep overbite one upper central incisor had escaped control by the lower lip and had erupted outside it. In each case the level of this central incisor was much higher than its fellow of the opposite side (*Fig.* 3, A, B).

The method of study was to lift away the upper lip in such a way as to cause the least possible amount of distortion of the lower lip and thereby ascertain the level of the lower lip in relation to the incisors. With practice this can be done without much alteration in the level of the lower lip. However, study of the lower lip line by the use of profile X-rays offers a method of greater accuracy. The general X-ray shadow of the lips may give a mistaken impression of their level at the midline unless the significance of the small triangular shadow seen in *Fig.* 4, A is realized. In *Fig.* 4, B an X-ray of the same patient is shown with radio-opaque paste painted on the midline of the lips. It will be seen from this that the small triangular area is in fact the junction of upper and lower lips in the midline. The use of radio-opaque paste in profile X-rays seems to offer the best method of study.

For the future much has yet to be studied and observed. The shape of the lip line as viewed from the front could have an effect on the incisor position. A lip line simulating an inverted "V" would bring a much greater depth of lower lip to bear on the central incisors than the lateral incisors. While the central incisors

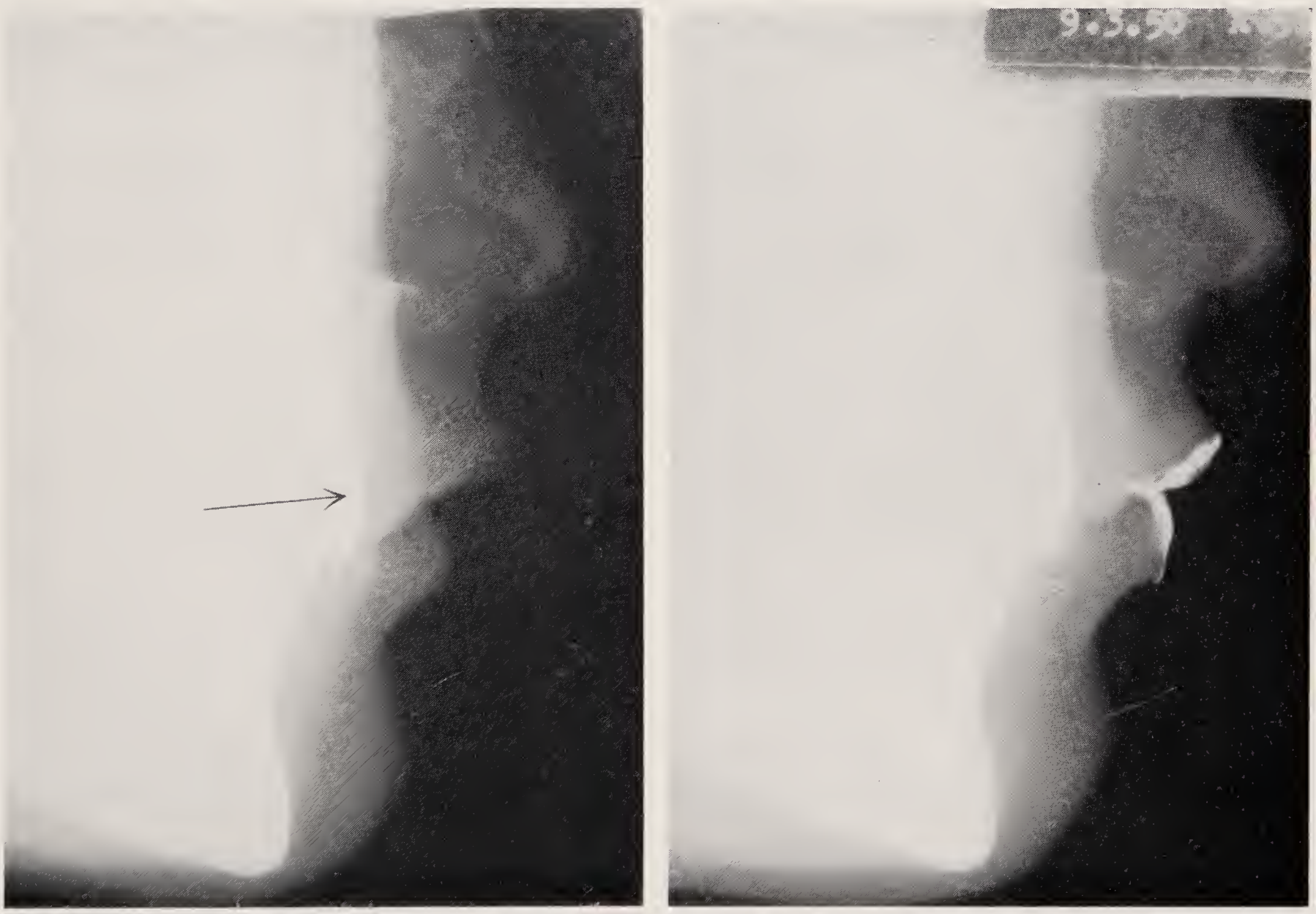
would be tilted lingually the laterals would be allowed to escape labially, producing the Angle's Class II division 2 type of incisor formation.

With further investigation we may find that muscle morphology goes hand in hand with skeletal morphology and neuromuscular behaviour patterns, forming syndromes which produce the common types of malocclusion familiar to us all. With further knowledge of the morphology of the environmental muscles of the teeth and jaws we may find that we are



A B

Fig. 3.—A, Upper lip lifted aside to show $\underline{1}$ controlled by lower lip and $\underline{|1}$ escaped control. B, The same case showing difference in vertical height of $\underline{1|1}$.



A B

Fig. 4.—A, Profile X-ray of soft tissue. Arrow indicates triangular shadow which is junction of upper and lower lip in midline. B, The same case with radio-opaque paste on the lips in the midline.

able to fit yet another piece to the puzzle of orthodontic diagnosis, and have a clearer picture of the total problem we face.

I am indebted to Mr. C. F. Ballard, Professor A. I. Darling, and Mr. W. Trevor Johnson for encouragement and advice in the preparation of this paper, and to the University of Bristol Medical Photography Department for the photographs.

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DISCUSSION

Mr. R. E. Rix congratulated Mr. Nicol on his report on an aspect of the problem of the environment of the incisors which needs a great deal more investigation and study.

He referred to a case known to Professor Rushton of a child growing up without an upper lip. He did not recall the pathology of the case, but the fact that the relationship of the upper to the lower incisors was normal confirmed Mr. Nicol's statement that the lower lip influenced the relationship of the upper to the lower incisors and the position of the upper incisors.

He had always been doubtful about the influences which controlled the degree to which the upper incisors erupted, and was not convinced that the lips had any influence on their occlusal rise. He thought that the occlusal rise of the lower incisors was controlled by the immediate anteroposterior relationship of the upper and lower incisors, but did not know whether certain conditions fostered increased rise of the upper incisors.

He thought the examples given by Mr. Nicol, in which one central incisor had escaped from the lower lip and was then said to be shorter than the corresponding central incisor, could be explained by the degree of inclination. If room was made for that tooth to be retracted and alined with the corresponding central incisor, and it was retracted quickly, there would be no difference in level.

Mr. H. G. Watkin agreed with Mr. Nicol that the lips had a great influence on the teeth; the fact that orthodontists used an oral screen for the treatment of a case such as Mr. Nicol had shown almost proved this. The pressure from the lips was concentrated on the outstanding incisor. Mr. Rix had said that if there was room the tooth would go back quite easily, but whether it stayed back depended on the inclination. If the apex of the tooth was so far backwards that the incline remained and the lower lip might still catch the upper incisor, it would not stay back. If an appliance was used and the tooth oscillated so that the apex came forward and the incisor was well in line, it would probably stay back.

Mr. W. J. Tulley asked whether Mr. Nicol had studied the familial aspect of the subject.

Mr. Nicol, in replying to the discussion, referred to Mr. Rix's point about the lack of an upper lip. He said it had occurred to him to try to look for cases with a cleft of the lip without a cleft of the alveolus. As to Mr. Rix's remarks about the difference in level, the point he had tried to make was that where there was an increase in the height of the upper incisors, the teeth must be tilted lingually. The reason he had shown the two cases, in which one incisor was tilted lingually and one had escaped forward, was to show that it was not the one forward which was at the wrong level, but that the one lingually inclined had moved farther down and had produced a deep over-bite of the incisors. Mr. Nicol said that he had not studied the familial pattern, but might do so in the future.

I. SURGERY IN CLEFT LIP AND PALATE

By **W. G. HOLDSWORTH**, F.R.C.S.

Surgeon, Rooksdown House Plastic Surgery Unit, Basingstoke

A NUMBER of individuals are concerned in the treatment of cleft lip and palate, and it is important that they should know something of each other's activities. This brief outline of the early surgery is submitted in the hope that your comments and criticisms will be forthcoming.

SINGLE CLEFT OF THE LIP

The lip may be closed surgically at any time after birth, and to-day some modification of the method introduced by Le Mesurier in 1949 is favoured by the majority of surgeons (*Fig.* 1). With this technique it is feasible, in one operation, to produce a lip and nose which are nearly normal in appearance. A general anæsthetic may be given safely to a child of 10 lb. weight, provided he is fit. On the other hand, there is no need to delay closure until that time, and in the first few weeks of life closure is perfectly feasible under local anæsthetic. (*Fig.* 3.) The operation is less hurried, but because the lip is so small the surgeon must wear an operating loupe.

An easier approach is to use two stages. At the first operation at six months the edges of the cleft are simply pared and then sewn together in layers without thought of a shapely lip or a good scar, in fact with no care at all except to join the muscle (*Fig.* 2). At the age of 4 years the lip is rebuilt with care to make shape and scar satisfactory. Shaping the lip is easier because the parts have grown so much, but the scars are never so unobtrusive as those from the earlier operation.

Where the cleft extends through alveolus and palate as well, and the lip closure is done under general anæsthesia, the anterior part of the palate may be closed if there is time. This is a measure of convenience, because the front of the palate is more difficult to approach after the lip closure. Mucosa from the septum is brought across to the edge of the palatal plate and sutured either to the nasal mucosa or to the buccal mucoperiosteum (*Fig.* 4).

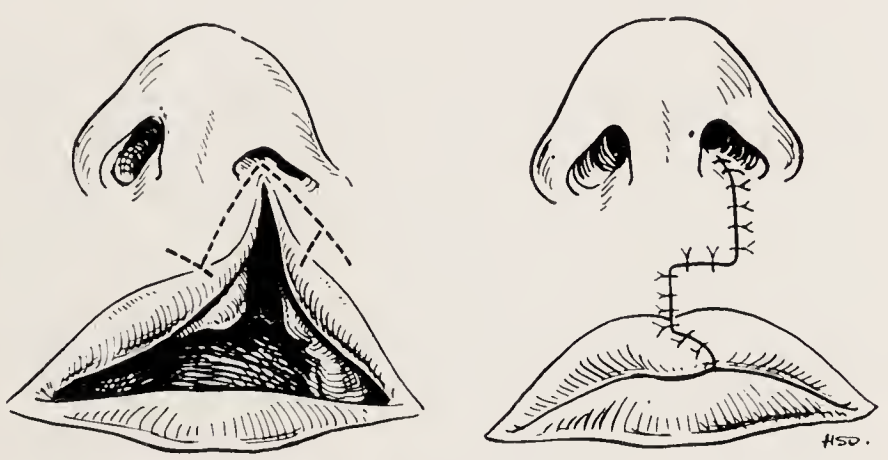


Fig. 1.—The method of Le Mesurier, by which it is possible to produce a lip and nose of nearly normal appearance in one operation.

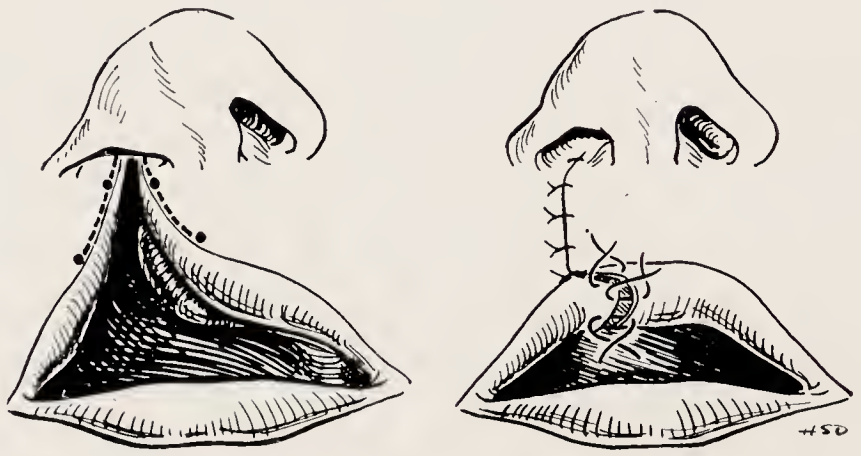


Fig. 2.—As an alternative, the lip may be pared and sewn together in layers at the first operation. Reconstruction is carried out at the age of 4 years.

DOUBLE CLEFT OF THE LIP

The clefts here are very wide, since, unrestrained by the lip with its band of muscle, the premaxilla is able to swing forwards and upwards, carrying with it the central portion of lip, or prolabium.

The closure is made first on one side, then on the other, with four weeks between. Each edge is pared with care to preserve as much

Being the first contribution to a symposium at the meeting held on February 8, 1954.

skin as possible, and closure is effected in layers. The anterior palate on the operated side may be closed at the same time. Closure of the lip subjects the premaxilla to a measure of gentle control, and brings it nearer alinement with the maxillæ.

Both clefts may be closed in one operation if the prominence of the premaxilla is reduced surgically by section of the septum. Victor Veau, of Paris, who personally operated on

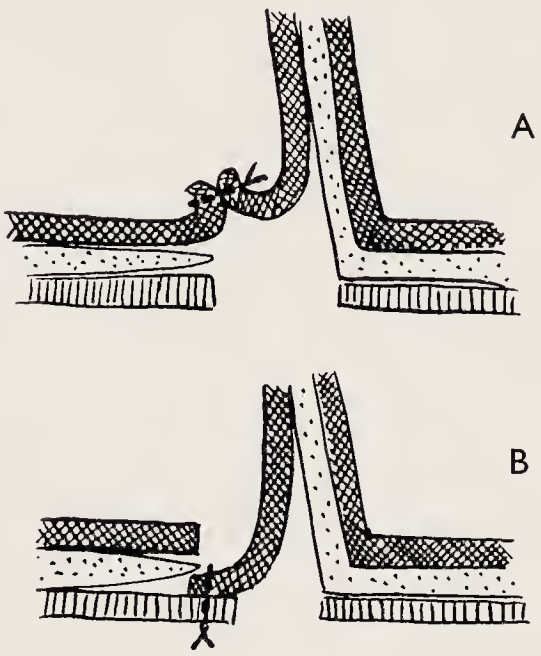


Fig. 4.—Closure of the anterior palate by suturing septal mucosa to either (A) nasal mucosa, or (B) buccal mucoperiosteum.

208 cases of double cleft, was impressed with the unfortunate results of interference with the vomer or premaxilla, and observed that these may not be manifest until late adolescence. Atrophy of the bone was noted following simultaneous dissection of mucosa from either side of the nasal septum even where it was not divided, and the insertion of wire sutures through the premaxilla was found to have the same effect.

Reduction of the prominence by ablation of the incisor teeth or removal of the anterior surface of the premaxilla, while improving the immediate appearance, was found ultimately to be disadvantageous.

In the presence of a cleft there is always some degree of deficiency of tissue, and in these double cases this is most marked. This is the principal reason why a result comparable to that available in single clefts is difficult to achieve, and why further operations later in life are more likely to be required.

CLEFT PALATE

Closure is carried out under intratracheal anæsthesia, and the surgeon may think of Langenbeck, a century ago, carrying out much the same procedure with the only anæsthesia available, ice rubbed on the mucosa.

The steps in the operation may be summarized.—

1. Paring the cleft in the soft palate.
2. Lateral incisions from the hamuli which skirt the alveoli and pass forwards to the canine region.
3. Cross-cuts which join the lateral incisions with the cleft, either the front of the cleft where this is comparatively short, or the sides of the cleft where it is extensive. (*Fig.* 5.)
4. Elevation of mucoperiosteum so as to free the flaps completely from the bony palate.

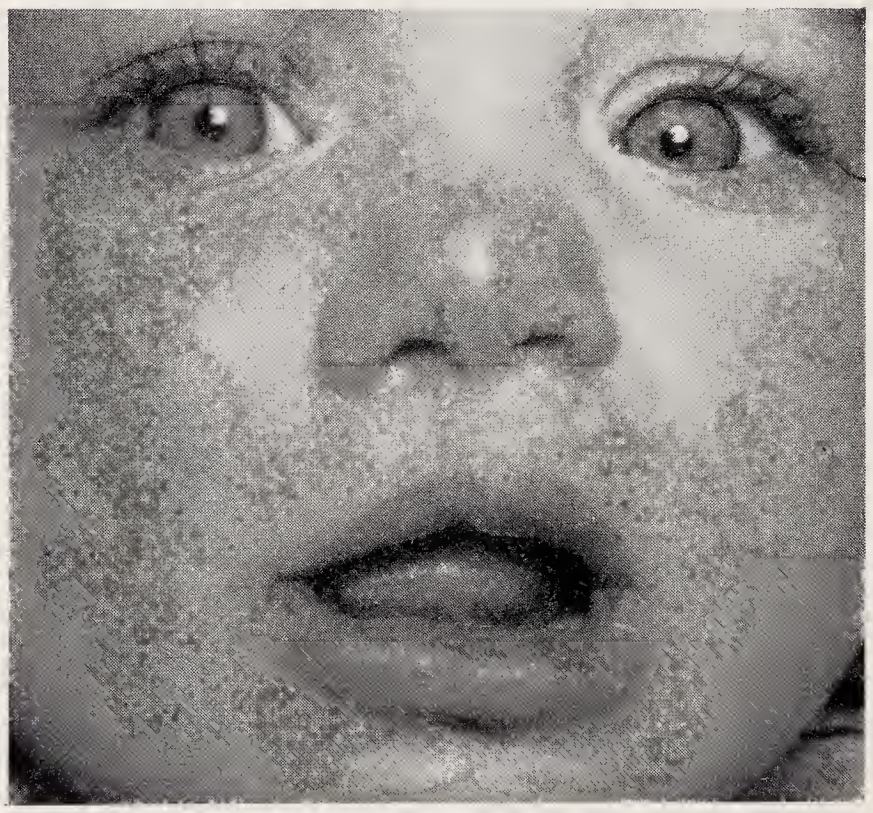


Fig. 3.—Child aged 6 months, who was born with a wide and complete cleft of the left side. This was closed at the age of 19 days, under local anæsthesia.

The edges of the cleft in the hard palate are opened in continuity with the paring already done in the soft palate.

5. The greater palatine vessels are identified as they emerge from the bone, and carefully loosened as they course through areolar tissue for about 5 mm. before entering the mucoperiosteal flap.
6. Eaeh pterygoid hamulus is exposed by blunt dissection, and the tendon of the tensor palati sectioned medial thereto.

7. Nasal mucosa is dissected from each medial pterygoid plate, and then from the palatal plates. In a wide cleft where the edge of the vomer presents, this may be incised sagittally and thereafter denuded of mucosa, which on turning laterally will aid nasal closure.

8. The nasal mucosa is closed with sutures of fine silk.

9. The buccal mucoperiosteum and mucosa are closed with mattress sutures of the same material. In the soft palate three of these sutures take a large bite of the muscle, and in that these complete the muscle sling which can later move the palate their insertion may be regarded as the crux of the procedure.

There are a number of points which are of importance:—

1. Mucosa and mucoperiosteum must be freed from the bone radically, so that there is no tension on the fine silk sutures. If these are tight they will cut through within a few days.

2. The greater palatine vessels should be preserved from damage.

3. The lateral incisions should not be too close to the alveoli, so that the chance of teeth being distorted by nearby scar is, therefore, minimized.

4. The relative inaccessibility of the anterior end of the palate in the presence of an intact lip has been mentioned, and this is a situation where closure most often proves unsatisfactory. The usual cause is failure to open the cleft all the way; if buccal and nasal mucosæ are left in continuity for just 1 mm. this is enough to guarantee a fistula. If the dissection in this area were scrutinized in a dental mirror prior to suturing, many of these fistulæ could be obviated.

5. Silk sutures do not require removal, they come away by themselves.

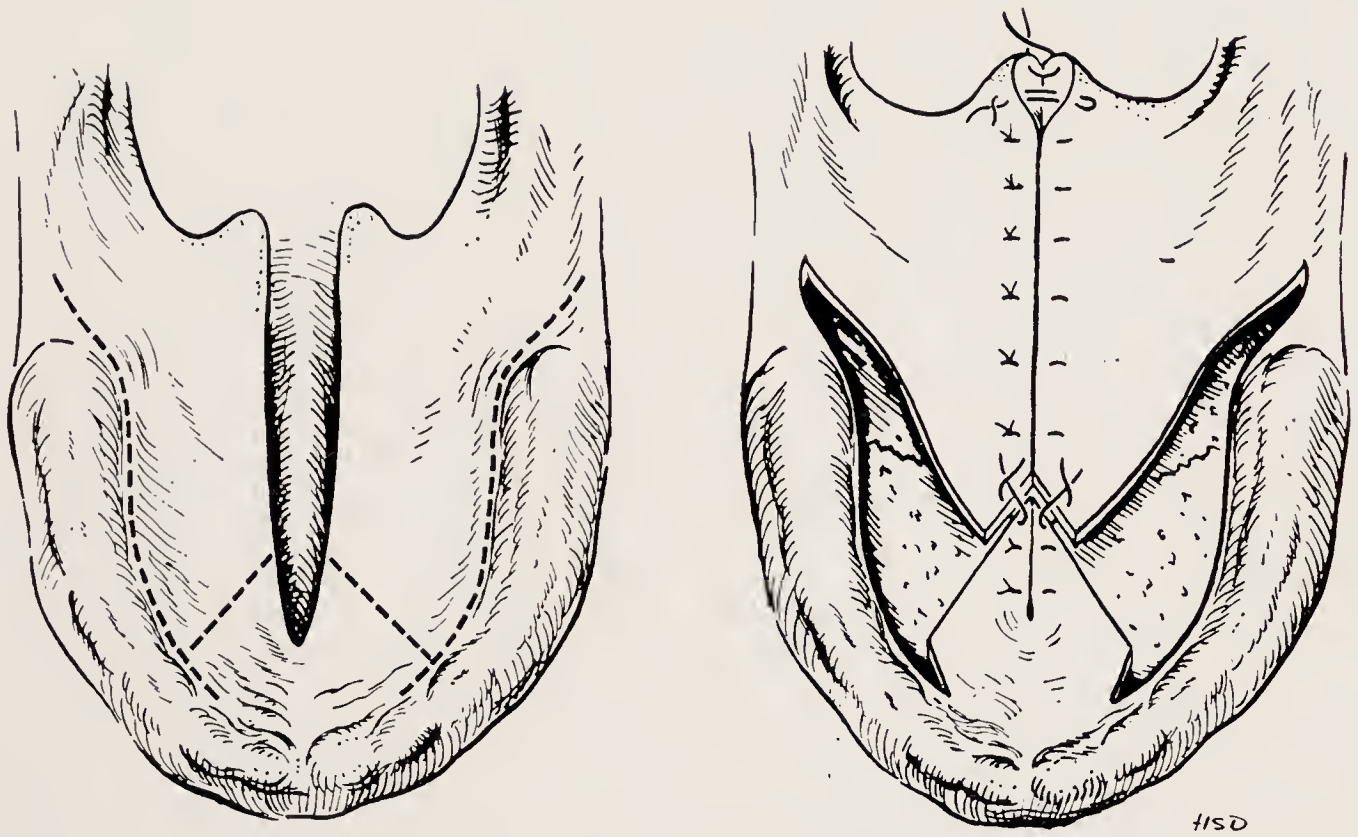


Fig. 5.—Closure of the palate in two layers, employing short anterior and long posterior mucoperiosteal flaps.

With regard to the age for operation, examination of a small series of personal cases has shown that where the palate has been closed between the ages of six and nine months, 77 per cent were speaking normally, and this is a much better figure than for cases operated on later. Since the series was small, and speech is not easy to assess in children, this percentage may require revision in a few years, but it is outstanding enough to indicate that better speech may be anticipated if operation is performed at this period.

II. THE DEVELOPMENT OF THE ORTHODONTIC PROBLEM

By **M. A. KETTLE**, F.D.S. R.C.S.

BEFORE the successful orthodontic treatment of cleft palate can be undertaken it is necessary to have an understanding of the problems peculiar to these cases and of the factors which contribute to their dental deformity.

Fig. 1.—Models of child, aged 6 months, with complete unilateral cleft lip and palate. Immediately before lip operation.

The orthodontic problem is created by the combination of a varying number of adverse influences which act on the growth and development of the upper arch. Cases of complete unilateral cleft lip and palate will mainly be considered, although the other groups will be discussed to illustrate a particular point.

THE NATURAL TENDENCIES OF THE ARCHES WITHOUT LIP OPERATION

A child born with complete unilateral cleft of the lip and palate does not possess a state of balance between the hard and soft structures of the mouth. Normally the arch development is influenced by the counteraction of the stimulating forces exerted by the tongue and the restraining action of the lips. In complete unilateral cleft lip and palate the restraining and moulding influence of the upper lip is lost to a great extent so that the tongue is capable of exerting an unrestrained forward thrust upon the anterior part of the upper arch. In addition to this the tongue bulges upwards into the space of the cleft palate, with the result that the width of the cleft is increased.

This increase in the width of the cleft due to the lateral displacement of its segments, whilst occurring on both sides in unilateral cleft, takes place mainly on the affected side so that the smaller segment is rotated laterally. The other side is not affected to the same degree because of its attachment to the nasal septum.

Delay in the lip operation usually allows this displacement to proceed. *Fig.* 1 shows the model of a child whose operation was delayed until the age of 6 months. It will be seen that the anterior part of the arch which belongs to the larger segment also projects forwards. This displacement may be due to:—

a. A lack of restraining lip action.

b. The forward thrust from the tongue.

c. The forward growth of one side of the dental arch unopposed by the restraint of the other jaw segment.

Being the second contribution to a symposium at the meeting held on February 8, 1954.

d. Unrestricted forward growth of the nasal septum which is attached to the large segment side.

THE FACTORS WHICH MAY CONTRIBUTE TO THE DENTAL DEFORMITY

The factors which exert a particular influence upon the growth of the jaw at a given time and may also culminate eventually into a typical cleft lip and palate deformity will be considered. These factors may be summed up:—

a. The medial deflection of the maxillary segments after the primary lip operation.

b. A lag in the downward and forward influence exerted by the nasal septum.

c. A defect in the forward thrust of the upper arch due to the surgical interference of the pterygo-palatine and the transverse palatine sutures in the first instance and later due possibly to the presence of avascular scar tissue in relation to these sutures.

d. The avascular property of scarred palatal mucosa limits the process of appositional growth of bone which brings about descent of the palate.

e. The absence of the forward development of the upper arch owing to defective upper lip activity.

f. Soft-tissue interference with the forward development of the upper arch and forward displacement of the lower incisors may be caused by tongue action during deglutition.

g. The defective growth potential of the bone in cleft-palate patients.

THE INITIAL INFLUENCE OF THE LIP OPERATION

In the past, surgical thought has followed a policy of compression of cleft-palate segments together, even resorting to the use of clamps to achieve this end. This method was based upon the erroneous idea that the maxilla in cleft palate was wider than normal and that the cleft was in all cases the simple failure in union of well-developed segments. It is known that surgical closure of the cleft lip will bring about in turn a closure of the cleft between the anterior alveolar portions of the upper jaw (*Fig.* 2). This movement is the reverse of the lateral displacement which occurred before operation and is the result of rotation about a fulcrum, probably in the region of the maxillo-zygomatic suture.

The movement is due at this stage not so much to the tightness of the lip tissue as to the action of the lip muscle upon two unstable

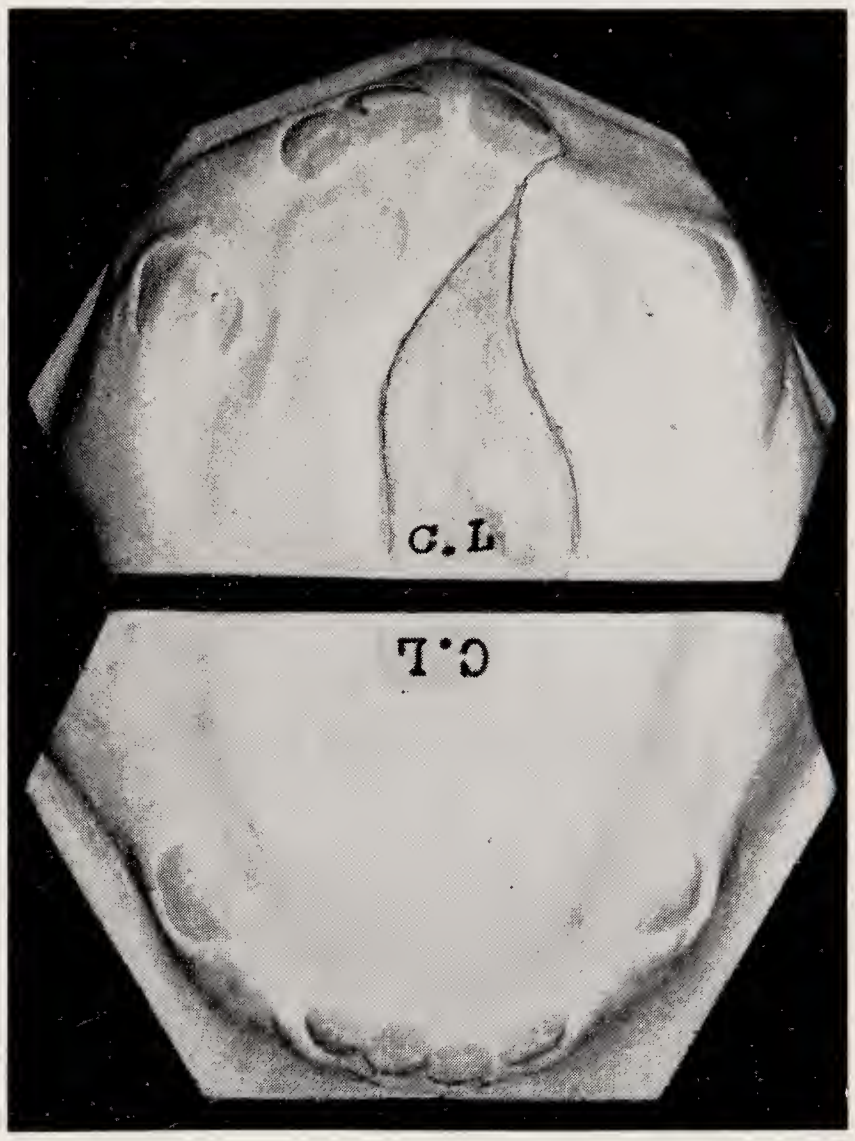


Fig. 2.—Models of child, aged 18 months, immediately before palate operation. Shows medial displacement of upper arch segments following lip operation.

mobile segments of bone which do not appose to one another in the midline. The contact anteriorly of these two segments when it occurs achieves a temporary state of balance. The smaller unattached segment usually moves the greater distance medially until it rests against the larger segment. The arch thus becomes narrow, probably because the greatest pressure is exerted in the region of the modiolus of the lip.

This response, which is the common one, is not always seen and even at this stage it is possible to discern two different types of response to the action of the lips. The different response arises where the pressure appears to

be anterior. An excellent profile of a child at 18 months who had a lip operation at 2–3 months of age is seen in *Fig.* 3. The lip,

Fig. 3.—Excellent profile result at age of 18 months, following lip operation at age of 2 months.

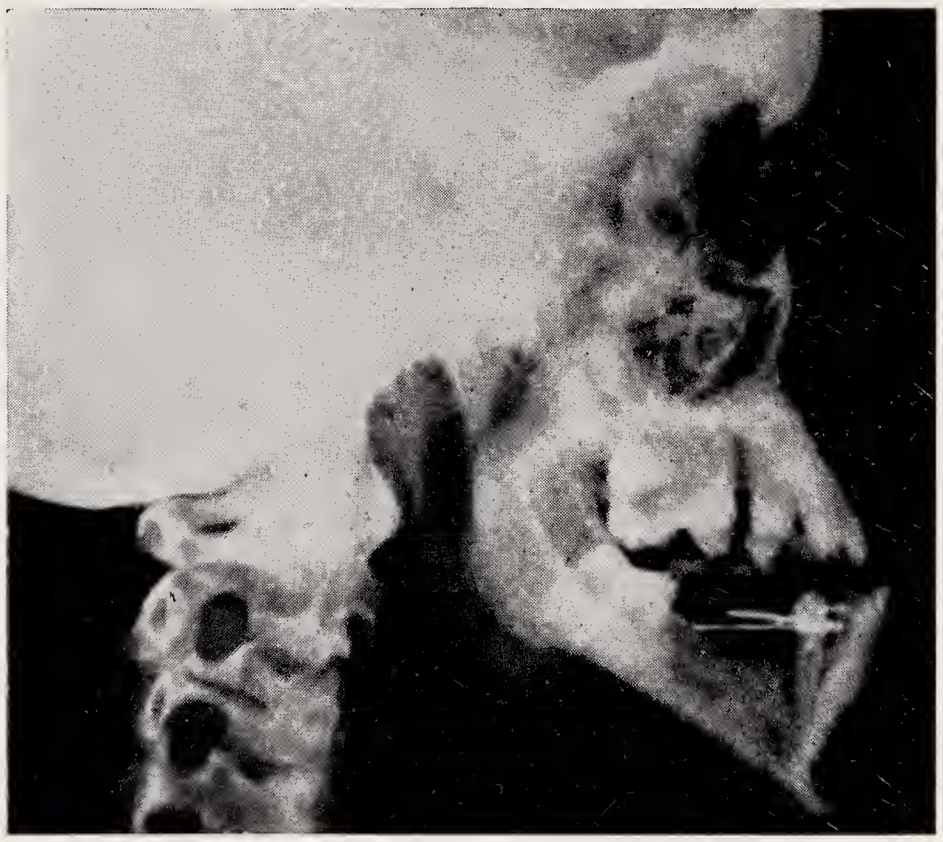


Fig. 5.—Lateral X-ray of patient, aged 17 years, who sustained severe burns in nasal area when 3 years old. (*By courtesy of Mr. N. L. Rowe, Plastic and Maxillo-facial Unit, Rooksdown House, Basingstoke.*)

however, is thick, with scar tissue attached high on alveolus, and a palatal displacement has occurred of the teeth and anterior part of the arch. The incisor teeth are in prenormal occlusion (*Fig.* 4). The lesser segment has not been displaced as far medially. The upper

Fig. 4.—Models show condition immediately before palate operation at age of 18 months. Note backward displacement of upper incisors, but good arch width.

arch is short anteroposteriorly and wide laterally. The different arch form may be brought about by an excess local pressure acting upon the anterior part of the upper jaw.

THE VARIATION OF THE NASAL SEPTUM

Brash (1924) quotes experiments performed by both Fick and Landsberger. They found that the removal of a section of the anterior part of the nasal septum in young animals resulted in an abnormal upward growth of the snout in each case.

THE EFFECT OF PATHOLOGY ON THE NASAL REGION

A child, who at the age of 3 years sustained severe burns of the nasal region, shows a marked defect in the forward development of the arch. She had a rhinoplasty at the age of 11 years which involved the nasal septum. This injury, which was localized, has resulted in a gross facial and dental deformity by the age of 17 years. A lateral skull X-ray of this patient is shown in *Fig.* 5.

Two patients who had irradiation treatment for a hæmangioma in the nasal area, one at 2 years and the other during the first year of life, were examined. Both of these patients showed gross facial and dental deformity due

to the deleterious effect of the irradiation treatment upon the downward and forward development of the actively growing bone in and around the upper arch.

The nasal septum is very sensitive to any change in its environment or to any interference with its structures. This may result in a failure of growth, as we have seen, or in an overgrowth of the septum.

OVERGROWTH OF NASAL SEPTUM DUE TO CHANGE IN ITS ENVIRONMENTAL PRESSURE

A child born with a complete bilateral cleft lip and palate shows a forward and upward projection of the prolabium. This is probably due to the loss of the normal restraining influence of a complete upper jaw and lip. An exaggerated growth occurs in the vomer bone.

The septal response to a unilateral complete cleft of the lip and palate is different. The nasal septum is attached to the unaffected side but undergoes rapid growth in a medial direction towards the affected side. This response may be due to asymmetry of pressure between actively growing arch segments and the nasal septum. Both of these conditions illustrate an exaggeration of vomer bone growth resulting from a release of environmental pressures.

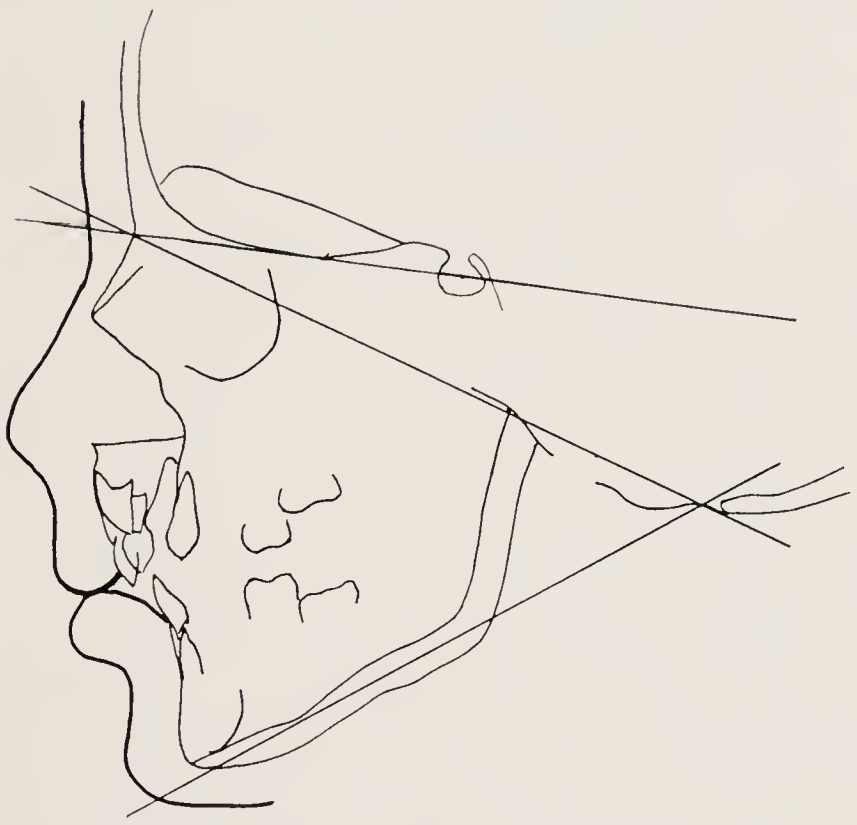


Fig. 6.—Tracing of lateral skull X-ray of child, aged 3 years 6 months, with bilateral complete cleft lip and palate. The vomer bone was not sectioned at operation.

THE RESPONSE TO OPERATIVE PROCEDURES ON THE NASAL SEPTUM

The extreme sensitivity of the nasal septum to any change results in a considerable variation of its response to different operative procedures.

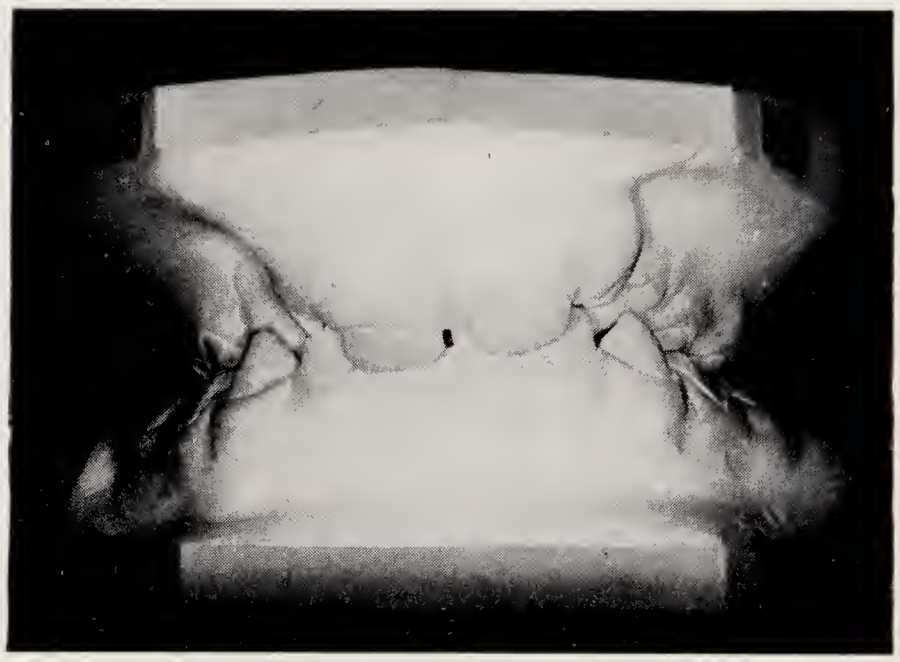


Fig. 7.—Models of same patient, showing deep incisor overlap.

a. **No Interference with Vomer Bone.**—In bimaxillary cleft lip and palate the initial operation effects a closure of the lip in front of the displaced prolabium. The vomer bone is not sectioned. The result of this operation is a gradual backward traction of the projecting tissue so that some restraint is offered to the forward growth of this part. A tracing from a lateral skull X-ray of this child shows the prolabium held forwards upon a stalk-like vomer bone. It is completely disassociated from the two maxillary segments (*Fig.* 6). The models show the downward and forward projection of the upper incisors giving rise to a marked incisal overlap. This is a favourable condition for a cleft-palate child. The buccal segments have moved into linguo-occlusion (*Fig.* 7). The medial displacement of the buccal segments is due to muscular activity in the modiolar region. The arch is long anteroposteriorly and narrow laterally. The anterior segment is supported in a forward position.

b. **The Removal of a Section from the Vomer Bone.**—Some surgeons remove a section from the vomer bone to facilitate the backward displacement of the prolabium. While an initial advantage may be gained, this results in a failure of the vertical growth of the anterior segment. Backward displacement of the segment by the lip occurs and there is an apparent recession towards the base of the nose (*Fig.* 8).

c. **Removal of the Prolabium.**—Complete removal of the bone from the prolabium results in great deformity. The soft tissues of the structures are sometimes utilized to reconstruct the columella of the nose. There is a gross failure of the upper jaw to develop in all planes. The upper lip is thick and immobile. The upper arch has remained stationary in the face of active downward, forward, and lateral growth proceeding around it. The mandible is maintained in a resting posture by the soft tissue, which is relatively normal. This is made possible by a greatly increased free-way space. The tongue is usually postured forwards against the upper lip. Graber (1949) has demonstrated a marked increase in the free-way space as growth of the face takes place.

THE SUTURES WHICH INFLUENCE THE DOWNWARD AND FORWARD GROWTH OF THE FACE

Weinman and Sicher (1947) have shown the parallel arrangement of the suture lines concerned with the downward and forward growth of the face. They are the fronto-maxillary, the pterygo-palatine, the zygomatico-maxillary, and the zygomatico-temporal sutures. Growth activity continues until about 20 years of age. The pterygo-palatine suture is the only one which is likely to be affected by the palatine operation. The suture line between the sphenoid bone and the vomer is parallel to the other four suture lines. Brash (1924) did not consider that this structure contributed in any important degree to the downward and forward growth of the normal upper arch. The variation of its effect in cleft lip and palate is marked and this region merits further investigation.

THE TIMING OF THE OPERATION ON THE PALATE

The cleft-palate individual makes a double impact upon the outside world, through speech and appearance. They are placed in that order

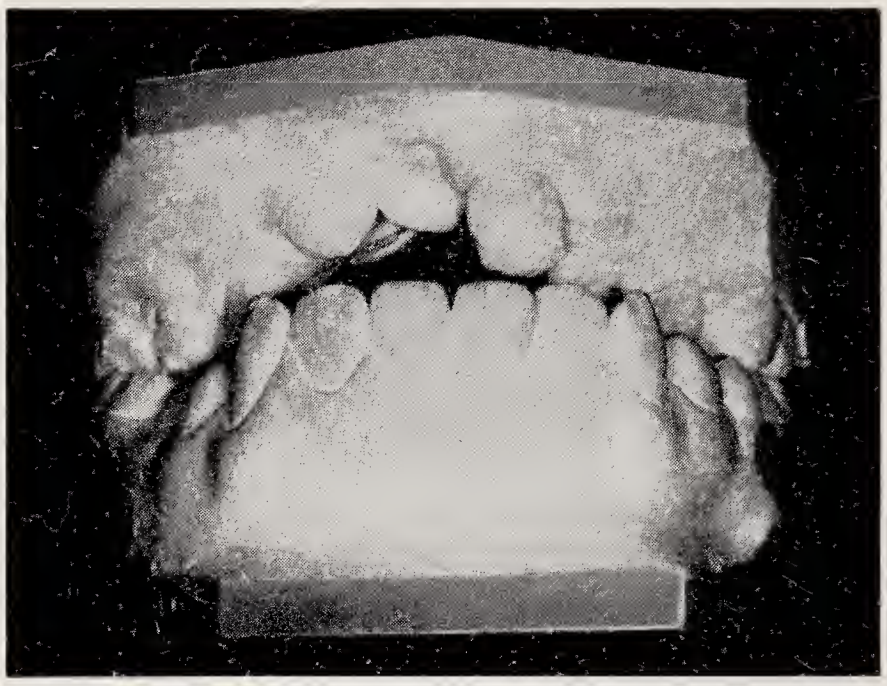


Fig. 8.—Models of patient, aged 17 years, with bilateral complete cleft lip and palate. Lack of forward and downward projection of prolabium following section of vomer bone at early operation.

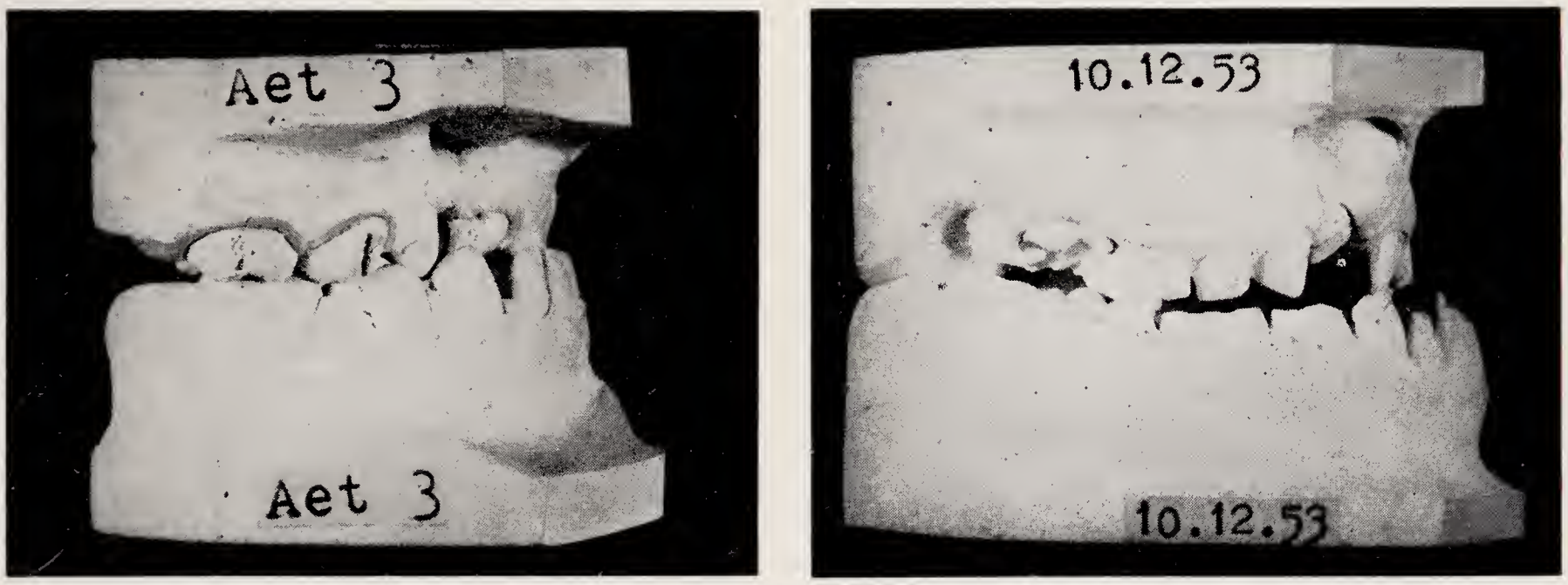
of priority with the proviso that the appearance can be improved by orthodontics and retained by prosthesis.

The generally accepted rule in this country is to operate on the palate at about 2 years of age. There is considerable controversy about the timing of this operation. Dorrance (1933) considers that 5 years is the ideal age and Graber (1949) has said that surgical closure of the palate should be postponed at least until the fourth year of life.

The sutures which are open at the age of 4 are as follows: The medial-palatal, the premaxillo-maxillary, the transverse-palatine, and the pterygo-palatine sutures. Cartilaginous junctions are present between the basi-occiput and the sphenoid bone and also at the occipital condyle. The initial cleft palate involves the median-palatal and the premaxillo-maxillary sutures. The mucoperiosteum is stripped from the transverse palatine and the pterygo-palatine sutures during the palate operation. The palatal tissue is also elevated from the bone surface. Both Brash (1924) and Todd (1931) have shown from work on normal skeletal material that five-sixths of the total

maxillary width has been completed by the fifth year and the entire lateral width by the tenth year.

Brash showed that the length of the palate doubles itself in the course of growth from birth to 20 years of age. Two-fifths of this growth takes place between birth and the fourth year. A comparison of skulls at birth and at 4 years demonstrates that the main change which occurs is the formation of alveolar bone to accommodate the erupting teeth. Clinically it is found that the first marked deterioration towards deformity occurs



A B

Fig. 9.—A, Models of patient at age of 3 years, showing cheek teeth relationship. B, Same patient at 7 years, showing lack of forward projection of upper arch and marked deterioration in cheek teeth relationship.

in the 5- to 7-year age-group. A rapid change in incisor and molar relationship towards pre-normal occlusion may occur at this time. These changes would be associated with a deficient downward and forward growth of the upper arch. During and after the eruption of the first permanent molars a rapid increase in palatal length occurs in the normal. The transverse palatal suture maintains a constant relationship mesial to the newly erupting permanent molars during this growth phase. There is a proportional increase in both the palatal process of the maxilla and the palatine bones. Professor Wood-Jones (1946) has stated that the distance between the posterior nasal spine and the posterior wall of the pharynx is constant throughout life. Active bone growth at the cartilaginous junction of the basi-occiput and the sphenoid bone results in a considerable forward projection of the bones of the face.

The transverse palatine and pterygo-maxillary sutures are in a state of great activity as the anteroposterior length of the upper jaw is increased. The condylar suture, which is partly concerned with the compensating growth of the base of the skull, closes after eruption of the first permanent upper molars.

A similar picture of growth activity is seen in the upper jaw between the age of 9 and 12 years. A great increase in size occurs at about the age of 10 years. The transverse palatine suture is seen to be mesial to the newly erupting second permanent molars.

The growth centres which influence the zygomatico-maxillary buttress apart from the median palatal suture are not affected by the palatal defect. It is not surprising, therefore, to find that the width between the molars is relatively normal. This may also be due partly to a release of medial pressure exerted by the tendon of the tensor palatii muscle which passes around the hammular process. This process is often fractured to allow for a decrease of tension in the soft palate.

In the face of this evidence it would appear that the choice of a late palate operation at 5 years of age may involve the growth centres in gross disturbance at the time that they are most active.

EFFECT OF THE PALATE OPERATION

The patients with incomplete cleft of the hard and soft palate alone appear to experience difficulty in speech development. A great proportion of them develop fistulæ of the palate. These two factors may be indications of the tension set up after the palate operation where there is no compensating movement of the arch segments as in complete cleft of the palate. Deformity of the arch and poor speech can usually be related to the amount of scar tissue present and to a history of repeated operations usually for a closure of fistulæ of the palate.

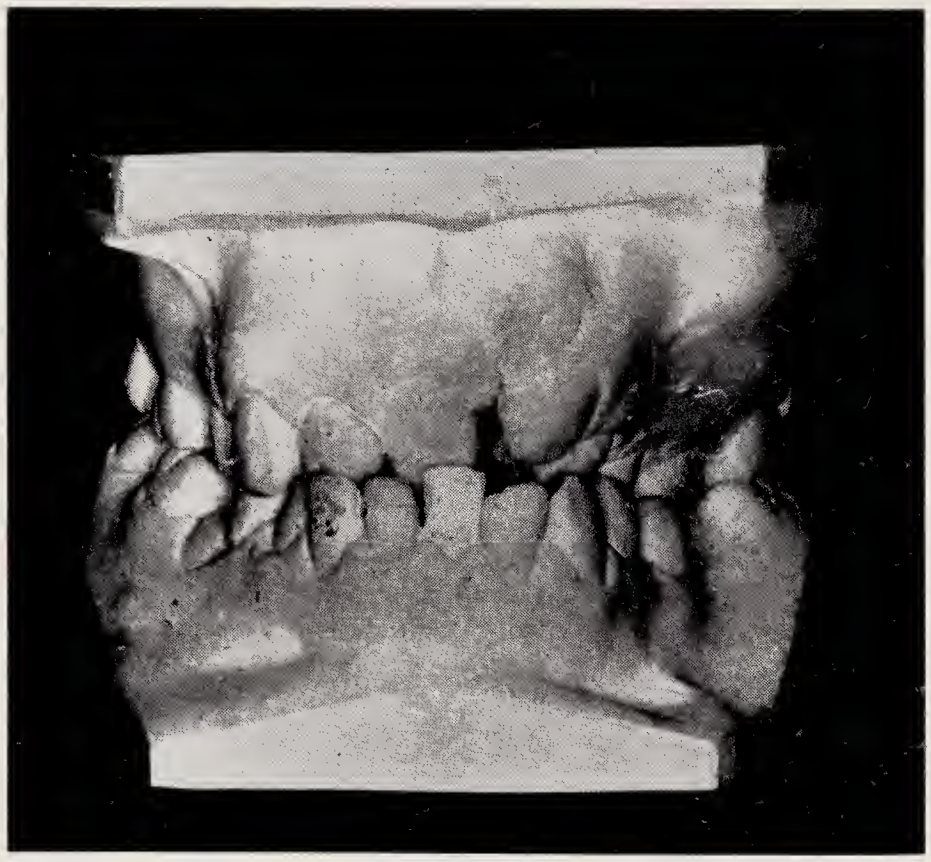


Fig. 10.—Patient with complete unilateral cleft lip and palate. No operation on palate. Deformity following lip operation at early age.

The models shown in *Fig.* 9 A of a patient with complete unilateral cleft lip and palate show that the arch relation at the age of 3 is relatively normal. A thick immobile lip has displaced the temporary upper incisor teeth inside the lowers.

Fig. 9 B shows the same patient at the age of 7 years. A marked defect in the forward projection of the cheek teeth has occurred. The incisal relationship has also undergone a marked deterioration, probably as the direct result of the palate operation upon sutural growth. The relation between the degree of deformity and history of operations together with the amount of scar tissue laid down, requires careful investigation.

A comparison of two patients with unilateral complete cleft lip and palate will be considered. One of these patients had a lip operation only and no palate operation. The changes at the anterior part of the arch due to the influence of the lips can be seen, but the arch segments have developed relatively well (*Fig.* 10). The other patient had an operation on the lip but had a long series of palate operations (*Fig.* 11). The deformity seen is probably partly the result of active interference with the growth sutures influencing the palate, but the other important factor to be considered is the avascular property of the scar tissue covering the palate. Bone growth requires a plentiful blood-supply, which is lacking under these conditions. The descent of the palate in line with the growth of the other structures is brought about by a process of resorption and deposition of bone in the palate. An arrest of this process may

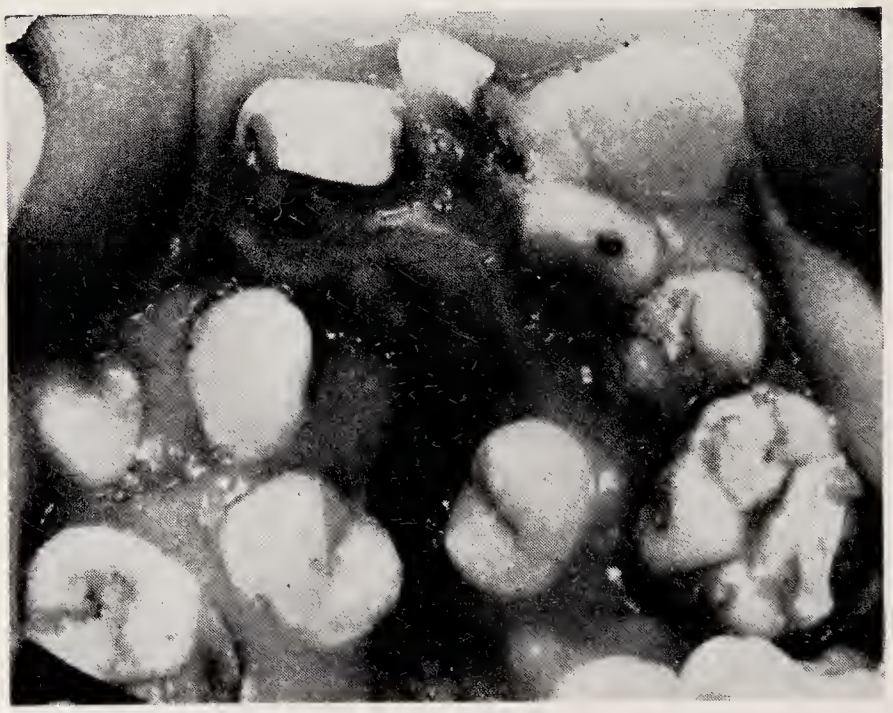


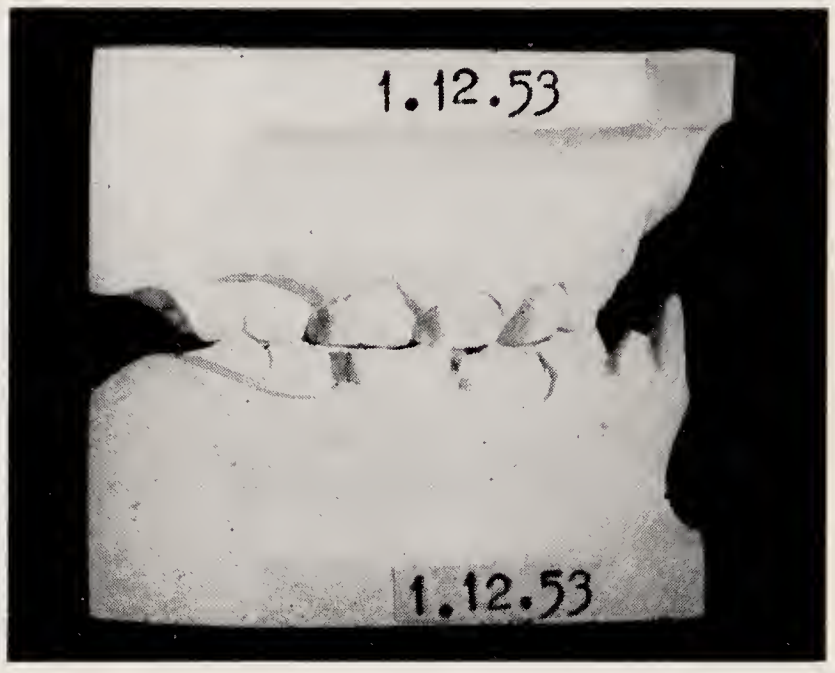
Fig. 11.—Patient with complete unilateral cleft lip and palate. Deformity following early lip operation and serics of operations on palate.

be due to the poor blood-supply of heavily scarred palatal mucosa. A further contributory factor may be the division of the main vessels of the palate during operation. An upper arch which has not descended to its normal position will be deficient in all dimensions. The marked irregularity of the teeth is more likely to be due to this factor than to the pull of scar tissue.

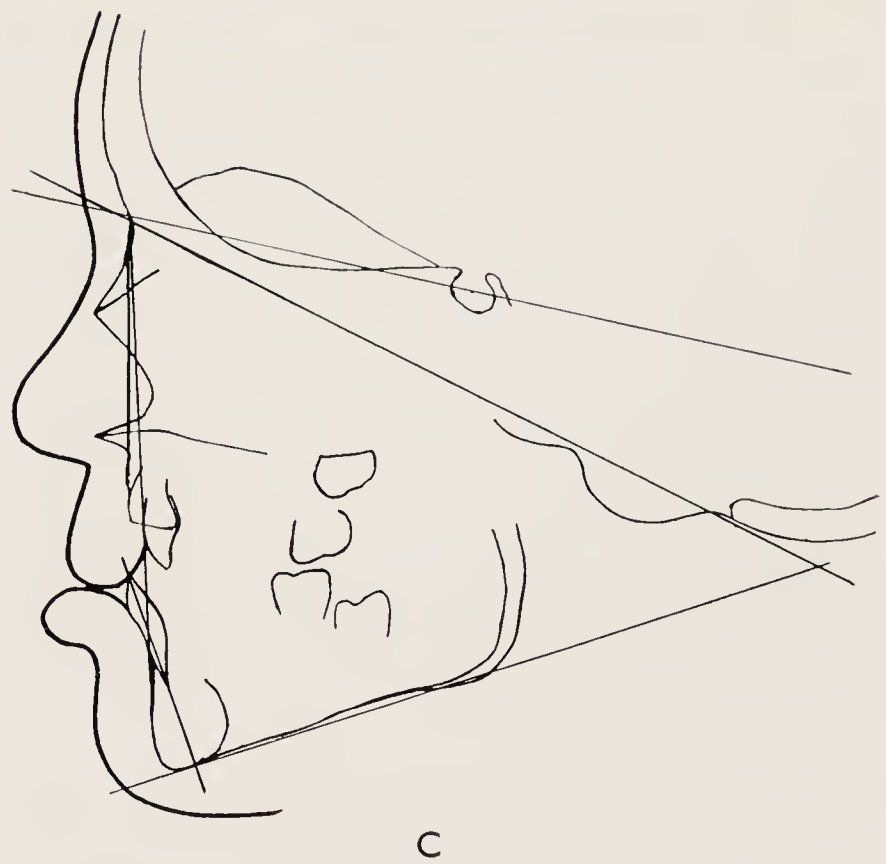
THE INFLUENCE OF THE LIPS

The immediate result from the lip operation may be very pleasing. A normal baby has a fullness of the upper lip, and although good lips are seen after operation, this fullness is usually lost in the cleft-lip patient. As the child grows there is noticed an increasing discrepancy in the upper lip, which in proportion to the remainder of the face does not appear to develop at the same rate. The inequality of the lips and their muscular activity is reflected in the arch formation.

A



B



C

Fig. 12.—A, Arch relationship at age of 6 years in patient with unilateral complete cleft lip and palate. B, Deterioration in arch relationship in one year during change-over from temporary dentition to permanent dentition. C, Tracing of lateral skull X-ray of above patient. Adverse lip posture associated with reversed tongue action during deglutition.

There are a number of ways in which the lip may affect the development of the arch: (*a*) A local displacement of teeth; (*b*) Changes in the incisal relationship; (*c*) It may exert a mechanical barrier to the forward translation of the upper arch.

The upper lip may be deficient in size owing to the agenesis of lip tissue. The incisal relationship is so affected that any influence the mandible might have exerted upon the forward growth of the maxilla is lost. Such a lip is usually thick and immobile, so that the lower lip is hyperactive and used during speech.

Another important change occurs under these conditions. The usual tongue to lower lip swallowing pattern, as described by Rix (1952), is reversed so that the muscle play takes place between the tongue and upper lip. The effect of this forward and upward thrusting action of the tongue is to protrude the lower incisors and retract the upper incisors. An added deformity may occur in the absence of some incisal teeth.

When segments of bone are under compression from muscle forces their size in the alveolar region is largely determined by the number of teeth present. In partial anodontia the lip and tongue action is capable of projecting the anterior segment distally, especially in bimaxillary cleft of lip and palate. Conversely, the presence of several

supernumerary teeth may have the beneficial effect of maintaining the anterior part of the arch in a forward position.

THE ORTHODONTIC PROBLEM

It has already been stated that the upper arch deformity in unilateral complete cleft lip and palate may assume two different patterns.

The one unfavourable type occurs where the upper arch is short anteroposteriorly and wide laterally owing to excessive backward

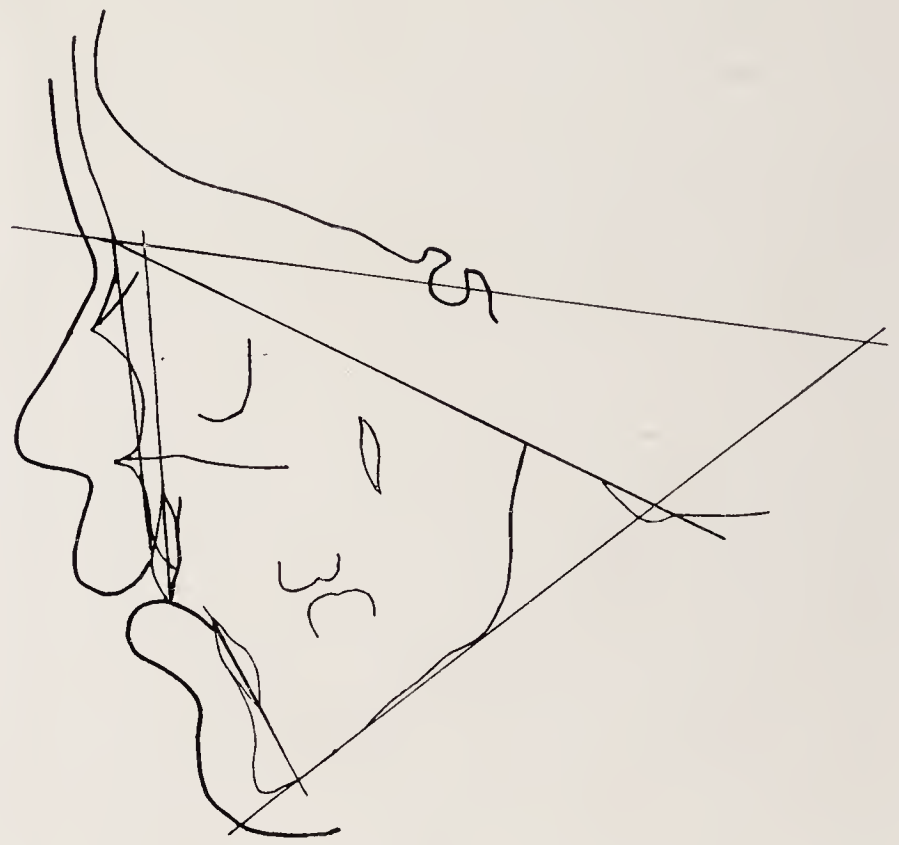
A

displacement by the lip in the incisal region during the early stages of arch development. This displacement occurs when the repaired lip becomes immobile, thick, and tense in posture. The lower lip under these conditions is usually loose and very mobile.

The change-over in the dentition from the temporary incisors to the permanent teeth is often accompanied by an increase in the deformity of the incisor relationship. *Fig.* 12 A, B shows the change which has occurred in one year. There has been a deterioration in both the molar and incisor relationship. The tracing from a lateral skull X-ray shows the abnormal posture of the soft tissue (*Fig.* 12 C). The lower incisors have been displaced forwards by the action of the tongue during deglutition. The interaction between the tongue and the thick upper lip causes a recession of the upper incisors.

These movements are atypical and occur during the tooth-apart swallow which is common to all cleft-palate patients.

The favourable type of patient with unilateral complete cleft lip and palate shows a facial pattern which is more normal in appearance. The upper lip is postured forwards, is



B

Fig. 13.—A, Favourable deformity associated with unilateral complete cleft lip and palate. Upper arch long anteroposteriorly and narrow laterally. B, Tracing shows favourable balance between lip and upper incisors.

normal in thickness, is relatively mobile and shows little tendency towards tightness. The development of the upper arch shows a characteristic form which is long anteroposteriorly and narrow laterally (*Fig.* 13 A). The medial displacement of the lesser segment, which is more marked in these cases, may play some part in holding the anterior part of the larger segment in a forward position.

The X-ray tracing (*Fig.* 13 B) shows that the posture of the lips is relatively normal and that during deglutition a typical tooth-apart swallowing action is performed. This

muscular action probably plays an important part in the maintenance of the incisor relationship, especially during the transition period from the temporary incisor teeth to the permanent dentition.

The same two distinct patterns of arch development are found in patients with complete bilateral cleft lip and palate. The tendency towards arch deformity is always more marked in these cases. The influence of the anterior pressure from the lip in the unfavourable type causes a gross backward displacement of the separate premaxillary element. The size of this anterior segment and the number of teeth present will influence the amount of movement. The excessive lip pressures are also liable to produce a more marked medial rotation of the two buccal segments (*Fig.* 14 A).

The favourable arch form in complete bilateral cleft lip and palate is long anteroposteriorly because the premaxillary segment is maintained in a forward position. There is a marked medial deflection of both buccal segments until they move into contact with the anterior segment (*Fig.* 14 B).

The most marked facial and arch deformity occurs when the bony element is removed from the prolabium. The result is a complete medial collapse of the anterior ends of the two buccal segments until they assume a state of rest in contact with one another. The result is a very short upper arch, although the molar width remains relatively normal (*Fig.* 14 C).

Graber (1949) found as the result of his investigations into cleft-palate deformity that:—

A B C

Fig. 14.—A, Short anteroposterior dimension of upper arch. Unfavourable type. B, Favourable type. Long anteroposterior upper arch. C, Gross medial rotation of buccal segments following removal of prolabium.

a. The maxillary height is less than normal.

b. The free-way space is greater than normal. An average of 7·2 mm. was found with a range existing between 1 mm. and 20 mm.

c. The angle of convexity, or N.A.P. angle, was less, giving rise to the typical deficient middle-third appearance of these patients.

d. The angle formed by the nasion, sella turcica, and upper first permanent molar was greater than in the normal. This was due to lack of forward translation of the upper arch.

e. The angle S.N.A. was less, showing the probable influence of the upper lip in its retarding action on the forward movement of the anterior part of the upper arch.

f. The angle between the lower incisor and mandibular plane is almost invariably less than a right angle.

The hereditary pattern which cleft-palate children assume may be Angle's Class I, II, or III. Graber found that the mandible is on an average slightly underdeveloped in relation to the cranial base.

CONCLUSION

The effect of cleft lip and palate and of subsequent operations upon the growth and development of the jaws has been reviewed. The influence peculiar to each factor has been considered, particularly in its effect on cases of unilateral complete cleft lip and palate. The variation in other groups is mainly one of degree.

The material has been obtained from the investigation of 60 cases, with an age range of 3 months to 20 years, who are suffering from varying degrees of lip and palate defect.

The following conclusions may be drawn from these investigations:—

1. Delay of the lip operation in complete unilateral cleft lip to 6 months or even 1 year will have a beneficial effect upon the forward displacement of the upper arch.

2. The nasal septum should be kept as free from surgical interference as possible. In complete bilateral cleft lip and palate the displaced prolabium may be moved back by traction and never by removal of a section of the vomer.

3. The primary palate operation can be performed as early as is practical and secondary operations which will increase scar tissue reduced to a minimum.

Acknowledgements.—My thanks are due to the Dental Council, Guy's Hospital, for providing photographic facilities; to Mr. Eckhoff, Mr. Rix, and Mr. Pringle for permission to show certain of the cases under their care at Guy's Hospital; to Professor Whillis for his kind advice in the preparation of the anatomical drawings and this paper; to Mr. N. L. Rowe for the use of material from the Plastic and Maxillo-facial Unit, Basingstoke; to Miss Treadgold, of the Department of Medical Illustration, for the illustrations; and to Miss Whitely, of the Photographic Department, Dental School, Guy's Hospital, for the preparation of photographs and slides.

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DISCUSSION

[A Précis of the Discussion following the Papers given by Mr. W. G. Holdsworth and Mr. M. A. Kettle.]

Professor J. Whillis, in opening the discussion, said that he had not been the first to describe the naso-pharyngeal sphincter muscle, as Mr. Holdsworth had said. It was Wardill who had first described it; Wardill had prognosticated that it would be there, and when they had looked for it they had found that it was there. This muscle was not attached to the hamulus; it missed the hamulus and went into the hard palate itself, so that it would not exert much of a pull on the hamulus itself.

The procedure of dividing the hamulus was supported by the contention that it allowed freedom to bring the parts together. That might be true, but the division of the tendon of the tensor, which Mr. Holdsworth carried out, would do precisely the same thing. Wardill stated that dividing the hamulus converted the tensor into a levator, but personally he thought that was nonsense. The tensor was a muscle which was concerned with depressing the palate, and it would therefore work whenever the palate was depressed. In closing the naso-pharyngeal sphincter the palate was elevated, and the central nervous system did not play tricks like that.

One point which he thought was of very great importance, and to which Mr. Holdsworth referred, was the relationship of the time of operation to the development of correct speech. It had been his experience that there were two groups of patients. Some of them, being provided with a normal mechanism at an early stage, would learn to speak normally, and that confirmed the view that the time at which to do the primary operation was before the child had learned to speak at all. There were, however, some children who did not learn to speak properly, and there must be some reason why normal speech did not develop in these children. Some might have a faulty organization of the central nervous system, and there were two forms which that might take. One was that hearing was deficient. Some patients could not tell the difference between their speech and any normal person's speech, and there was something odd about that. It was very difficult to see how such a patient could learn to speak normally. In these patients all the efforts made to produce a normal machinery of speech failed. There were other cases, however, which were left alone completely and yet spoke just as well as and perhaps better than many of the cases in which the palate had been repaired. These patients had somehow learned to compensate for their deformity.

Therefore he did not think that the problem was quite so simple as would at first appear from the better results in those cases in which the palate was repaired before the children learned to speak; but that, in his opinion, did not alter the principle that the time to do any operative procedure to provide a suitable mechanism was before the child had learned wrong habits of speech, which were very difficult indeed to lose once they had been acquired. For instance, when many of these children quarrelled with their brothers or sisters they went back to cleft-palate speech, even when the surgeon, the speech therapist, and the mother thought that their speech had become normal. In such cases the speech had become normal by voluntary effort, and when the speech became of an automatic character it was apt to revert to cleft-palate speech.

The problem of the effect of the lip on the development of the jaws seemed to him to be exemplified to some extent by the cases of cleft lip without cleft palate. If the lip was exerting a restraining influence on the development of the maxilla, one would see cases in which the development of the maxilla was deficient when the palate was normal, and, of course, one did see such cases, so obviously it must have some effect, but his impression was that the maldevelopments of the maxilla in such cases were minimal, and therefore the palate itself must have something to do with the deficient development of the maxilla. Mr. Holdsworth had mentioned the evils of stripping, and he thought that that was a point which needed a great deal of further investigation and the collection of data. He thought that most surgeons were beginning to agree with Mr. Holdsworth that the results of stripping might be disastrous, owing to the interference with appositional bone growth.

With regard to Mr. Kettle's paper, he would like to refer first to the author's point about avoiding the time of sutural growth for operative procedures. During the early stage of growth, sutural growth contributed very little, and therefore operative procedures performed at that time would be less likely to disturb it. He would like to refer, secondly, to the timing of Abbé's operation to increase the length of the upper lip. If these occlusal deformities occurred, and if they became more pronounced during the period when sutural growth was at its maximum, Abbé's operation, if it was to be done at all, must be done before that period, although the effect of the tight lip was less pronounced at that time.

There was one very significant point that Mr. Kettle had made. In describing one of his cases, he had said that the vertical height of the maxilla was deficient. That vertical height was, of course, the result of sutural growth and appositional growth, and it seemed to him that, if there was a real suppression of vertical growth, it indicated something inherently wrong in the tissues which were growing, because it was basal bone that was chiefly concerned, and not alveolar or palatal bone. If vertical height deficiency was due to the lack of alveolar growth, it would be a different matter, and he would like Mr. Kettle to clear up this point, because if it referred to basal bone he thought it was likely to indicate a deficient growth in the maxillary tissue, which he thought was present. Neither Mr. Holdsworth nor Mr. Kettle had made much mention of something inherently wrong in the make-up of these tissues which prevented them growing properly.

Mr. Kettle had referred to the tongue bulging into the cleft; Professor Whillis said he would like to suggest that, if the tongue was bulging into a cleft, it was of necessity narrowed from side to side, and that the

disturbance of the position of the segments of the maxilla when the lip was repaired might therefore, if the palate was not repaired at or about the same time, be due to a deficient lateral pressure of the tongue, because, since it was bulging upwards into the cleft, it could not bulge sideways and forward against the alveoli. It had never struck him before, but it struck him now, that part of the imbalance might be due to the fact that the tongue was not working properly, because it was bulging somewhere where it normally did not bulge, namely, into the cleft, and in that connexion the normal development of the arches, in cases in which an obturator was fitted and no attempt was made to repair the cleft, might be partly due to the fact that the tongue was then unable to bulge into the cleft and so remained of a normal breadth, producing its normal pressure against the teeth and the alveoli, which led to the normal expansion of the arch.

Mr. E. A. Hardy said that members were fortunate to have Mr. Holdsworth to describe the operation now used for cleft palate. His paper, together with the slides, had made the method very clear. He personally would have liked to hear more about this operation which was more important to orthodontists than operations on cleft lip.

Many people believed that cleft in the alveolar bone could unite, but this was not so, and only slight pressure on the teeth would open up the cleft.

He thought the fundamentals to be considered in these cases were, in their right order: (1) Speech; (2) Mastication; and (3) Appearance. If preferred, appearance could be put before mastication, but speech must always be considered first. The tight upper lips, referred to by Mr. Kettle, could be greatly softened by an orthodontic appliance.

Mr. D. S. Hayton-Williams said that one person of great importance in the work under discussion was the expert anæsthetist who enabled surgeons to carry out unhurried and precise operations. The type of operation performed was of less importance than the date. There were other people concerned, such as the speech therapist and orthodontist. It would help the surgeon and orthodontist if, when cleft lip and palate cases were discussed, the type was clearly defined.

The orthodontic problem was a complicated one. The plastic surgeon had only a few hours' work on an unconscious patient, whereas the orthodontist might have to work over a number of years on a conscious and possibly unco-operative patient. In his opinion, complicated procedures could not satisfactorily be executed by a dental surgeon on the written instructions of an orthodontist.

Mr. J. H. Hovell raised the point whether in cleft palate there was, in addition to the cleft deformity, a difference in the growth potential of the deformed parts. He personally was not sure that this was so. In primitive parts of the world he had seen untreated clefts (admittedly not severe ones) in which the development of the dental arches was normal. It was most important to attempt to determine whether there was growth deficiency in cleft palate, in order to find out how much the operative procedures interfered with growth. He felt that much interference *was* caused, both by the disturbance of growing parts and by formation of scar tissue. The cases with greatest deformity were those in which numerous operations had been undertaken to close clefts in the hard palate.

Mr. D. F. Glass said he had been appalled by the knots of scar tissue left behind after cleft-palate operations which orthodontists were supposed to try to stretch and move about. The older operations were the main cause of the deformity, apart from the developmental cause. In the case of the push-back operation, a picture had been shown in which nearly the whole of the hard palate had been stripped and pushed back, and there was a large area of scar tissue left each side of the palate, while the nerve-supply to the mucous tissue of the soft palate was, or probably would be, interfered with. Scar tissue was present and he thought the collapse of the two lateral sides of the dental arches was due to this, because it became worse as time went on. Unless orthodontic treatment was given between the ages of 4 and 5 years, the collapse of the lesser segment could actually be seen. The median displacement of the buccal segment was, in his opinion, due almost entirely to scar tissue.

He was not convinced that sutural growth of the palate was of great importance after 3 years because most of it had taken place by then. In any case, the sutural growth of the palate did not matter in cleft-palate cases when there was no growth in the soft palate. It was the middle sutures which gave the width of the palate.

He would like to ask Mr. Holdsworth whether he found speech difficulty when adenoids were removed after the palate had been closed, and whether the constriction of the muscles affected the palate after tonsillectomy.

He thought that in the selection of cases for speech therapy, it was the patient's I.Q. that mattered more than anything. Many of them had other developmental defects, both mental and physical.

He did not agree with Mr. Kettle that the earlier palatal clefts were operated upon the better. He thought that operation should be avoided as long as possible and that some system should be adopted whereby the palate was not stripped, but a graft was introduced to prevent tension across the palate.

Cleft lip and palate surgery was a little beyond the field of orthodontists, but as they were left to treat the chaos that remained after the operations, they ought to have some say in the matter. At present there was great lack of co-operation between surgeons and orthodontists.

Mr. W. J. Tulley said he had seen a child of 9 with untreated cleft lip and palate whose speech and oral development were excellent. He had seen a family with cleft-palate speech of a genetic pattern but without cleft palate. The whole problem was extremely obscure.

To-day plastic surgeons considered the orthodontic problem very fully, and, owing to improved technique, orthodontists did not see the gross distortions they had seen in the past. The orthodontic problem was proportional not so much to the surgical technique as to the lack of tissue. Tissue could not be increased without some being introduced into the mouth, which was now being done. The real orthodontic problems occurred in complete clefts, bilateral cleft lip and cleft hard and soft palate, but even in these cases the premaxilla element varied and the amount of tissue was one of the factors to be considered.

Obviously contracting scar tissue had something to do with failure of growth, as had the disproportionate elements of lip and tongue pressures; but he did not agree with Mr. Kettle that the septum was such an important factor in the pathological cases he had shown.

He thought one of Mr. Kettle's most important statements was on the question of the superimposition of

cleft-palate abnormalities on other skeletal abnormalities. There might be a Class II or a Class III case with a cleft palate, and the problem was directly related to the genetic build-up of the patient apart from the actual deformity.

Mr. J. C. Ritchie wished to know whether Mr. Holdsworth was in the habit of splinting his cleft-palate repairs when teeth were present. A number of cases he had treated had been splinted at the time of operation and he believed this greatly reduced deformity. He believed that these repairs, whether done by surgery or stimulation, should be completed before speech began.

Mr. H. E. Wilson, speaking of the downward growth of the middle third, recalled a paper read before the Society by Dr. Scott, of Belfast, who had convinced most of his hearers that downward growth did not take place at the suture after the second or third year but was mainly appositional growth. Mr. Kettle had shown an illustration demonstrating the effect of sutural growth in the downward direction and he thought Professor Whillis agreed that this was the mode of growth. He would like Mr. Kettle's views.

Mr. Holdsworth, in replying to the discussion, said Mr. Glass had raised an important point about adenoids and tonsils. He had seen more than one child whose palate had been closed with a good speech result which was jeopardized by removal of adenoids later. He did not like adenoids being removed in such children. He had seen no harm result from removal of tonsils provided the soft palate was undamaged. Shortage of tissue was fundamental in all the work in question—the surgeons tried to make something and had not enough tissue. He was grateful for Mr. Ritchie's suggestion about splinting when teeth were present.

Mr. M. A. Kettle, in replying to the discussion, said that Professor Whillis mentioned the effect of the lip in the development of the upper arch when there was a cleft there but not necessarily in the palate. The point to be considered was that the cleft might involve the deeper structures in the nose. If it did, there was a defect in the forward growth of the arch.

He thought the vertical height of the upper arch was both alveolar and basal. It was caused by the forward growth of the upper arch and the downward pressure due to the nasal septum coming together and pushing down, so he thought the effect of the nasal septum was considerable. The alveolar bones would also have an effect because the soft tissues present might displace or retard the downward growth of the teeth.

The tongue bulging in the cleft did not necessarily result in its becoming narrow; indeed, the tongue in cleft-palate children was much wider than normal. The point was that the freeway space was greatly increased so that the tongue bulged sideways between the teeth in the resting position and during swallowing.

He did not agree that the sutural growth of the palate was complete before 3 years. There was a great increase in the anteroposterior length of the palate after 5 years. Labial displacement of the buccal segments was not necessarily related to scar tissue in the palate, because it occurred before operation. It was mainly due to lip action.

Mr. Glass had referred to the graft coming across the defect in the palate. He had said in his paper that any interference with the vomer would decrease that growth.

Mr. Tulley had mentioned cases in which some mucous nasal resection was done. If it had been done early an orthodontist who followed up the cases would probably have been able to show some effect on the upper arch.

Mr. Wilson had suggested that the downward growth of the middle third was appositional. The remarks he had made in his paper had been based on the suggestion that it was sutural growth.

As to lack of co-operation between surgeons and orthodontists, he thought some were lucky and others not.

III. THE ORTHODONTIC TREATMENT OF DENTAL DEFORMITIES DUE TO CLEFT LIP AND PALATE

By **M. A. KETTLE**, F.D.S. R.C.S.

A REVIEW of the factors which contribute to the dental deformity in cleft lip and palate is necessary before embarking upon the orthodontic treatment. We must also determine which factors are likely to be influenced by this treatment.

THE CONTRIBUTING CAUSES OF DEFORMITY

1. A medial deflection of the maxillary segments after the primary lip operation due to forces exerted by the lips.

2. A lag in the influence exerted by the nasal septum on the downward and forward growth of the upper arch.

3. A defect in the forward thrust of the upper arch due to the surgical interference of the pterygo-palatine and the transverse palatine sutures primarily and later due possibly to the presence of avascular scar tissue in relation to these sutures.

4. Limitation of the appositional growth of bone which brings about descent of palate due to the presence of avascular scarred palatal mucosa.

5. The absence of the forward development of the upper arch due to defective upper lip activity.

6. Soft-tissue interference with the forward development of the upper arch and a forward displacement of the lower incisors which may be caused by the movements of the tongue to the upper lip during deglutition.

7. The defective growth potential of the bone in cleft-palate patients.

THE LIMITATIONS OF ORTHODONTIC TREATMENT

Many of these factors become fundamental in their influence to bone growth once they occur. An operation or a congenital defect which limits the capacity of a growth centre to fulfil its growth potential cannot be modified by orthodontic treatment.

The factors which can be modified are those due to the influence of abnormal soft tissue in the mouth. They are:—

1. A change in position of arch segments due to muscular forces.

2. The soft-tissue influences upon alveolar bone and on the position of the teeth.

3. A release of the mutual contact of the anterior part of the arch segments in complete cleft palate which permits deposition of alveolar bone in this region.

THE BASIC APPROACH TO ORTHODONTIC TREATMENT

In the past the medial collapse of the bony segments of the upper arch in complete clefts of the palate was always encouraged so as to create a firm, stable, bony mass upon which to build up prosthetic restorations. This usually entailed the acceptance of a gross dental and facial deformity which could only be modified by the use of extensive prosthesis.

Orthodontic treatment was usually confined to the modification of the local position of teeth. This approach was probably due to an acceptance of the fact that any improvement in the position of the collapsed arch segments produced an unstable result. These movements would be made in the face of abnormal muscle forces and unless retained by prosthesis would relapse into the original pattern. In addition to this there was the considered risk that any expansion movement of the arch segments might cause a breakdown of the scar tissue uniting them in the palate, together with the production of increased transverse tension in the soft palate, resulting in a deterioration in speech.

Being the third contribution to a symposium at the meeting held on March 8, 1954.

Harvold (1949), of Oslo, introduced a different approach to the treatment of these patients. Instead of accepting the collapsed position of the arch segments he showed that it is possible to move them back by expansion with fixed appliances into positions which approximate to the normal in their relationship with the lower arch. The scar tissue which joins the two segments in the palate does not break down as a result of this expansion movement, but any fistulæ which may be present increase in size. Far from any deterioration in speech it has been observed that there is considerable improvement and the soft palate becomes more relaxed. The expansion movement which results in a widening of the upper arch takes place mainly in the anterior part of the upper jaw in complete cleft of the palate; the fulcrum of movement probably being in the region of the maxillo-zygomatic suture. The movement of the medial edge of the palatal process of the palatine bone would therefore be in a medial direction. This movement may result in a decrease of the transverse tension of the soft palate. The changes in speech in a growing child are difficult to assess. Serial recordings of the child's speech are made on to a tape-recording machine in the Children's Department, Guy's Hospital, so that a continuous record may be made during development and treatment.

THE REACTION TO CHANGE IN THE ALVEOLAR CLEFT REGION IN COMPLETE CLEFT OF THE PALATE

The medial collapse of the segments due to the action of the lip muscles is considerably influenced by the presence of teeth in the region of the cleft between the alveolar processes. The teeth are usually seen at the extreme end of the defective border of the alveolus and the roots are covered by a thin layer of bone.

The exfoliation of deciduous teeth and the development and eruption of the permanent teeth is accompanied in the normal by the apposition of alveolar bone to accommodate the larger teeth. In complete cleft palate this exfoliation is usually accompanied by a further medial collapse of the arch segments due to the continuous muscular action of the lips. The loss of space which results from this movement creates a gross irregularity of the teeth adjacent to the cleft. The crown of the tooth projects towards the bony defect. There is probably a different rate of bone growth on each side of the tooth, that on the cleft side being slower than that on the other so that the tooth is tilted and rotated along its long axis.

Harvold (1949) has already described the further collapse that follows the extraction of teeth in the line of the cleft until a new state of balance is maintained between the forces exerted by the action of the lip muscles and the arch segments.

THE LOCAL ALVEOLAR RESPONSE IN COMPLETE CLEFT PALATE TO EXPANSION MOVEMENT

When the upper arch in complete cleft palate is expanded and the arch segments are moved out of contact a proliferation of soft tissue occurs on the cleft border of the alveolar process. This growth usually keeps pace with the expansion movement and is followed by the formation of alveolar bone. Sufficient alveolar bone is often laid down to allow irregular teeth to move into better alinement. This phenomenon seems to be confined to the alveolar region and is variable in its response. It is laid down more readily in the young, especially when the adjacent teeth are in a state of eruption. Soft-tissue interference may inhibit its formation. Mobile scar-tissue attachments from the lip to the outer border of the alveolus, an excessive scar bulge on the inner surface of the lip, or a playing habit of the tongue will all interfere with this bone formation. An inherent defect in the growth potential of cleft-palate patients may also be a factor.

THE AIMS OF ORTHODONTIC TREATMENT

1. To prevent the occurrence of gross deformity.
2. To restore the normal overall contour of the upper arch.
3. To relate the two arches in size by expansion in the upper arch and if necessary by extractions from the lower arch.

4. To encourage good functional exchange between the arches so that the mandible may exert an influence on the development of the upper arch.

5. To improve the profile and the facial contours.

EARLY ORTHODONTIC TREATMENT OF COMPLETE CLEFT PALATE

UNILATERAL COMPLETE CLEFT PALATE

As a general principle orthodontic treatment is avoided in unilateral complete cleft palate before the age of 5–6 years. It was shown in the previous paper that little suture growth in the palate either anteroposteriorly or laterally takes place between birth and 4–5 years. The main increase in size which takes place before 4–5 years is due to the apposition of the alveolar bone required to accommodate the deciduous dentition. The difficulty with co-operation in the very young together with the extended retention period required are the main disadvantages. Considerable emphasis, however, should be placed on the importance of conservative methods of treatment.

The success of the ultimate treatment, however, depends upon a forward position of the upper incisor teeth and the anterior part of the upper arch. Any tendency towards a prenormal incisal relationship should be corrected where possible. A marked defect in the incisal relationship at an early age can usually be attributed to the local pressure from the upper lip. The defects which bring this about may be scarring inside the lip, thickness of the lip, agenesis of tissue, or immobility of the upper lip. In these cases removal of the local cause by surgery will prove to be of great value. Where gross displacement of the anterior part of the upper arch occurs at an early age there is a very strong case for an Abbé flap or similar operation to be performed at the age of 5–6 years. A more favourable balance of the lips is thus created before the eruption of the upper permanent incisors and as the active increase in the anteroposterior length of the palate is taking place.

In those cases where the lip balance is favourable from the time of the lip operation the anterior part of the upper arch can be maintained forwards. In the favourable cases the lesser segment has been displaced farther medially. It is not necessary as a rule to

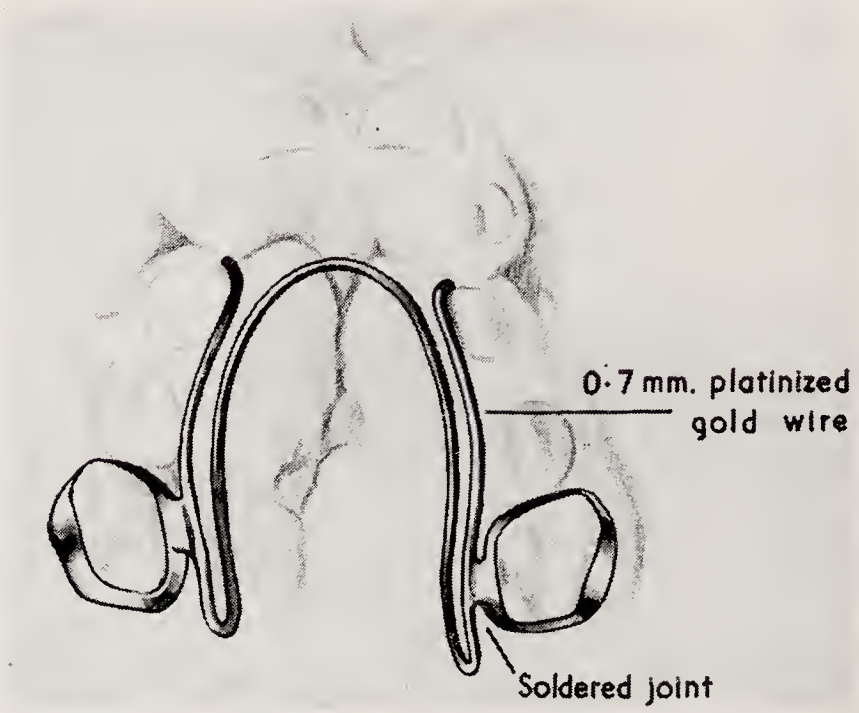

Fig. 1.—Modified type of W spring, soldered to anchor bands. For use in very young patients.

correct this displacement in unilateral complete cleft palate until the eruption of the permanent upper incisors.

COMPLETE BILATERAL CLEFT LIP AND PALATE

In complete bilateral cleft lip and palate so many factors are acting upon the growth and development of the upper arch, and these patients suffer from such gross deformity later, that it is advisable to initiate orthodontic treatment as soon as the child is old enough to co-operate. Bony reaction in the alveolar region to expansion treatment is much more marked in the young. A marked medial collapse of both buccal segments takes place after the initial lip operation. A lateral expanding movement of the buccal segments which moves the anterior ends of the buccal segments out of contact with the anterior premaxillary segment is followed by a deposition of alveolar bone next to the cleft line on the proximal edge of each segment. Sufficient space is created for the alinement of the temporary teeth and more room is made for the eruption of the permanent teeth into a good relationship with the lower arch. The segments have to be retained in their new positions, and in particular the anterior segment must be maintained in a forward

position. This is usually done with a simple removable appliance.

The Apparatus.—A simple appliance must be used for young children. A W spring made in platinized gold wire soldered directly to bands on E|E, as first suggested by Pringle (1950), is quite sufficient to move the two buccal segments into proper relationship with the lower arch (*Fig.* 1). The appliance is removed for each adjustment and re-cemented into position. Provided that an unimpaired exaggerated thrust by the nasal septum has occurred, the anterior segment is maintained well forwards by the occlusion of the lower incisors during this expansion movement. In those cases where a section has been removed from the vomer or the anterior lip pressure is excessive and the premaxilla has been deflected backwards, then this area will take prior claim to the initial treatment. This will be discussed later in the paper.

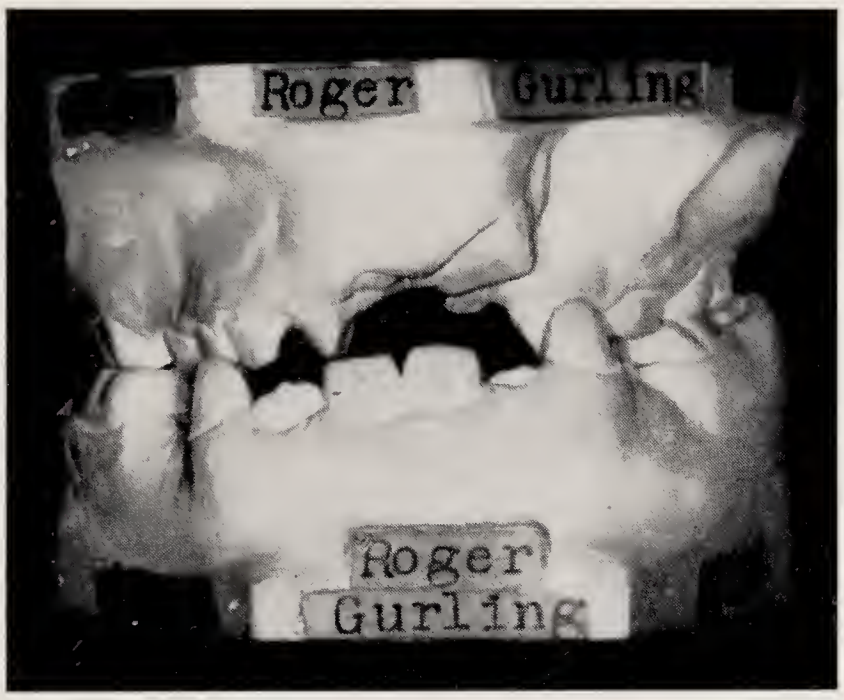

Fig. 2.—Before treatment.

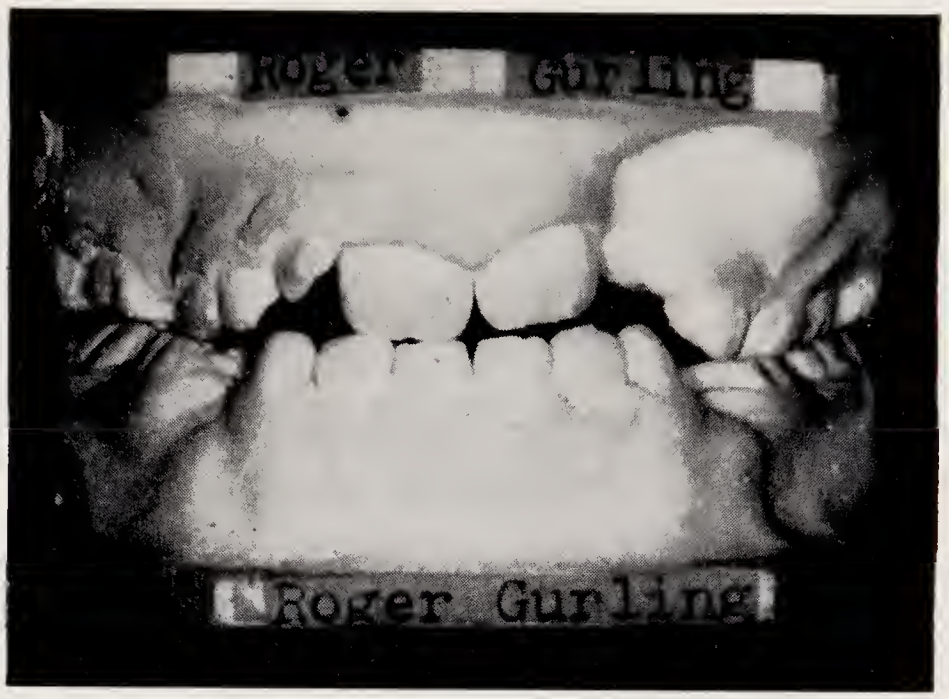

Fig. 3.—After treatment.

ORTHODONTIC TREATMENT AT THE OPTIMUM AGE OF THE DENTAL DEFORMITY RESULTING FROM COMPLETE UNILATERAL CLEFT LIP AND PALATE

The loss of the temporary upper incisor teeth and the eruption of the permanent incisors is usually accompanied by a further deterioration of the incisal relationship. The period of eruption of the upper incisor teeth is therefore found to be a favourable time to commence the orthodontic treatment.

When the child reaches the age of 6–7 years the dental deformity will generally be seen to have assumed one of two basic types.

The Favourable Type.—The upper arch is long anteroposteriorly and narrow laterally. The anterior part of the larger segment is supported in a forward position. There is considerable medial deflection of the lesser segment. The profile is good and the posture of the lips shows that a typical tooth-apart swallow pattern, as described by Rix (1946), is performed.

In a typical case considered the angle S.N.A. was 77·5°, which is less than the normal 80·79° (Reidel, 1948), showing a lag in the forward projection of the anterior part of the upper arch. The angle N.S. upper first permanent molar was 73°, greater than Brodie's (1942) figure for the normal (67·5°).

The Unfavourable Type.—The upper arch is short anteroposteriorly and wide laterally. The anterior part of the larger segment has been deflected backwards. The medial deflection of the lesser segment is not so marked as in the other type.

The profile is poor and the posture of the lips shows that an atypical or reversed tooth-apart swallow pattern is performed. It is interesting to note that angle N.S. upper first permanent molar is again 73°, but that angle S.N.A. is 75°, rather less than in the previous

case. This would indicate that the deficiency in the upper arch is more marked in the anterior region and is due more at this stage to the influence of an immobile upper lip. In such a case further surgery on the upper lip at this stage would decrease anterior pressure.

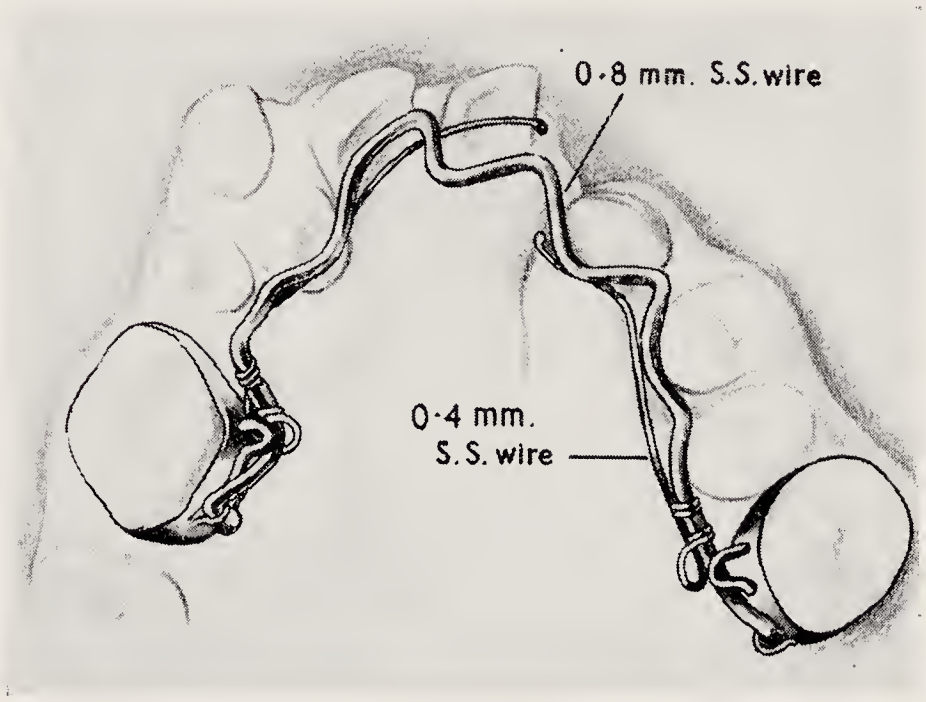

Fig. 4.—The appliance.

Treatment.—The principles of orthodontic treatment are the same for both types: the movement of the lesser segment laterally out of contact with the larger segment into a correct bucco-lingual relationship with the lower arch. A lateral expanding pressure is also supplied to the larger segment, which does not move as readily because of its attachment to the nasal septum. The movement of the larger segment is lateral in the upper canine region and laterally and forwards in the anterior part of this segment. The slight forward movement often has the effect of improving the incisal relationship. In the favourable type extra forward traction of the upper incisors is required and extraction of two lower premolars often necessary (*Figs.* 2, 3).

The aim of the treatment at this stage is to recreate the upper arch into a normal state, encourage extra bone growth, and maintain an adequate arch into which subsequent teeth can erupt into good positions.

The Appliance.—The type of appliance that Harvold uses for the treatment of complete unilateral cleft palate is shown in *Fig.* 4. Bands are constructed on the upper first permanent molars when possible, but if these teeth have not erupted sufficiently it is better to use the upper second deciduous molars. The lock attachment has a vertical Selmer Olsen tube and a staple of 0·6-mm. S.S. hard wire also welded to the palatal side of the band. This type of locking attachment has the great advantage that the palatal bow can be bent directly in the mouth out of slightly softened 0·8-mm. S.S. wire.

By this means a new bow can be made when movement has taken place away from the old bow. A stable appliance is necessary and this method of changing the palatal bow at regular intervals is found to be a satisfactory method of maintaining its stability. An auxiliary spring in 0·3-mm. or in 0·4-mm. hard S.S. wire with a high degree of mobility anteriorly is used to produce the rotation of the segments. A slight degree of tension is put into the main bow so that a wider range of movement is given to the fine wire. The fine wire springs are ligated into position so that their stability and efficiency are increased.

Occlusal X-rays will usually show the extent of the lateral expansion. Owing to the superimposition of other bony structures it is difficult to assess the extent of new bone which is laid down. The tracing from lateral X-rays shows that the forward movement of the incisors has not brought about any forward movement of the apices of these teeth (*Fig.* 5). When the upper arch has been

Fig. 5.—Superimposition of tracings of lateral skull radiographs of above patient. Before and after treatment.

moved into a favourable size and shape it is maintained by means of a removable appliance or denture. As soon as the patient is old enough this is replaced by a fixed bridge which serves to splint the arch segments in their expanded position.

ORTHODONTIC TREATMENT IN PATIENTS WITH A CLEFT OF THE HARD AND SOFT PALATE ONLY

Patients with incomplete cleft palate and intact alveolar arch do not show much arch deformity before the 5–6 year group. The degree of overbite before this age group usually decreases progressively owing to the lag in the downward and forward growth of the upper arch. This lag is probably the result of interference with appositional growth in the palate caused by the presence of avascular scarred palatal mucosa.

The absence of forward projection of the upper arch becomes more apparent from 5–6 years. The period of increase in antero-posterior length of the palate which is seen in the normal arch during the eruption of the first permanent molar is seen to be retarded in these patients with incomplete cleft of the palate. The upper permanent incisor teeth may erupt into prenormal occlusion, not in this case owing to the anterior pressure of the upper lip, which is usually intact, but to the defective growth activity in the pterygo-maxillary and transverse palatine sutures. The defective growth may be the result of the surgical interference with these sutures or to the subsequent deficiency in their blood-supply due to the presence of overlying avascular scar tissue.

The treatment of these cases is directed towards the establishment of the correct incisal relationship and sufficient lateral expansion to produce space for the eruption of the premolars.

The appliance used is a 0·8-mm. S.S. wire palatal bow attached to bands constructed on either the first upper permanent molars or on the second upper deciduous molars. The method of attachment described in the previous type is the most satisfactory, as it lends itself to a ready means of replacement of the bow as tooth movement is effected. Fine wire auxiliary Friel springs are used to move the teeth as described by Lilah Clinch (1935) in a paper to this Society. The movement of the teeth in these cases is the true

Fig. 6.—Superimposition of tracings of lateral skull radiographs to show the range of movement during orthodontic treatment of patient with repaired incomplete cleft of hard and soft palate.

orthodontic movement of tooth through bone, whereas in all the conditions of complete cleft palate the whole bone segment is moved, carrying the teeth with it.

The lateral skull X-ray tracings show the result of treatment in the case illustrated (*Fig.* 6). Unfortunately the upper arch is not stable in its finished result, so that it must be stabilized by prosthesis or bridge work. The other alternative is to stabilize relationship with premolar extractions, possibly lower first premolars and upper second premolars, but the result is not ideal because of a deterioration in the profile appearance.

THE McNEIL (1954) METHOD OF TREATMENT TO CLOSE PALATAL DEFECTS BY STIMULATION

A large proportion of patients who have successful primary palatal operations at an early age do not suffer from gross developmental defects of the upper arch. The criterion appears to be a single non-traumatic primary operation so that a minimum of scar tissue is laid down in relation to the developing bone. A marked lag in the growth of the upper arch or even gross deformity is often associated with

a history of secondary operations on the palate; usually for the closure of fistulæ, which have resulted from a partial breakdown of the primary operation.

At the last demonstration meeting McNeil demonstrated a method of closure of palatal defects as a result of stimulation of the cleft edges. A removable upper appliance was used to which was fitted two main movable parts. One, which was palatally placed, was moved by the action of the tongue, and this portion moved in turn two small elements suspended on fine wires into the palatal defect. The action of the two small elements agitated against the cleft edges of the defect and caused a proliferation of soft tissue to grow medially. The growth of the soft tissue is claimed to be followed by the deposition of new bone. McNeil showed models of cases in which complete closure of the palatal defect was brought about by this means. The great value of this treatment may be to provide a way of closing certain palatal defects without resorting to secondary surgical procedures on the palate.

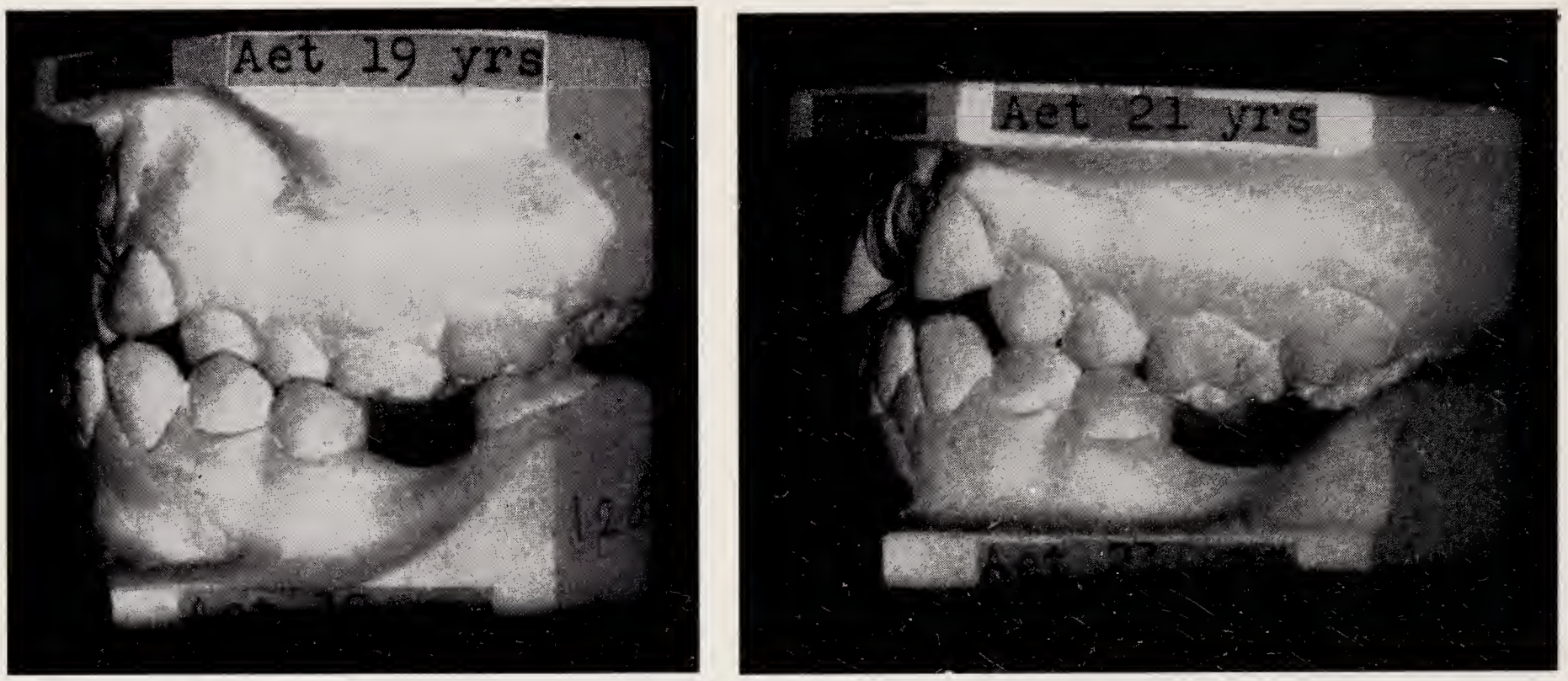

Fig. 7.—Models A, before, and B, after treatment.

LATE TREATMENT IN COMPLETE CLEFT LIP AND PALATE

The young adult patient in the 16–20 years age group presents a different problem. The activity of the bone-growth centres has largely stopped, so that there is little hope of encouraging general development by orthodontic treatment. The arch segments are in a state of balance with the lip muscles and with each other anteriorly (*Fig.* 7 A). The lesser segment is also deflected upwards, so that the vertical height of the teeth on this side is less than that of the greater segment which is attached to the nasal septum. The discrepancy in vertical height of the two segments arises from a difference in their capacity to offer resistance to upward forces exerted by the tongue.

The lip which has brought about a medial collapse of the arch segments by its muscular activity becomes itself adapted by contracting onto a bony foundation which has decreased in size. The profile is adversely affected by this further discrepancy in the posture of the lips. The upper lip becomes more fixed in its movements and offers greater resistance to any change in the position of the arch segments.

The forces of occlusion have usually played a part in fixing the segments of the arch in a stable position. This fact, together with the slower bone reaction to expanding forces, increases the difficulty in changing the arch form (*Fig.* 7 B). The scar tissue, which offers little resistance to expansion forces at an early age, now tends to bind the arch segments

together in the palate and resist the lateral movement of the arch segments. These adverse factors, together with the greatly increased masticatory forces in the young adult, make it necessary to use an appliance which is capable of exerting stronger forces and withstanding the increased risk of breakage (*Fig.* 8).

The Appliance.—Bands are constructed on the first upper molar teeth and fitted with vertical tubes on the palatal side. A W spring is bent from 0·6-mm. hard or 0·8-mm. softened S.S. wire. The locking arrangement is seen in the diagram. The anterior free ends are capable of exerting a lateral displacing force with a wide range of movement. The stability of the spring is increased by constructing bands on the upper canine teeth and soldering hooks palatally, to which the free ends of the W spring can be attached.

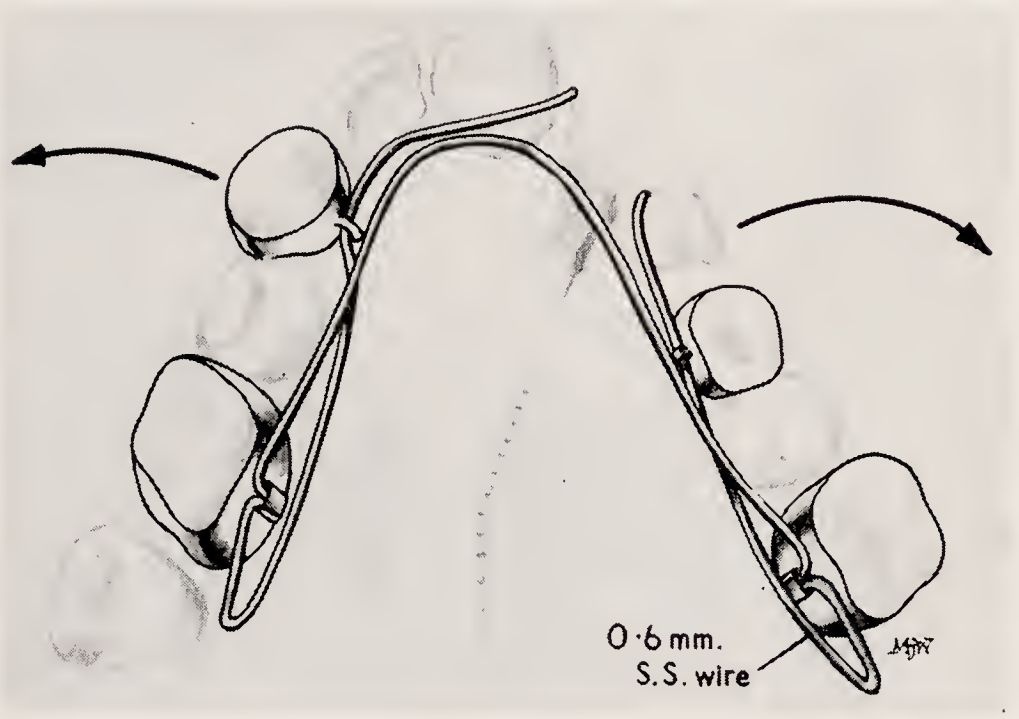

Fig. 8.—The appliance used in older patients.

The occlusal X-rays of the palate taken before and after the treatment, which lasted one year, show that considerable expansion has taken place (*Fig.* 9). There is evidence of some new bone deposition in the alveolar region. In the older patients there is often seen a reactive proliferation of the alveolar tissues as the arch segments are moved out of contact.

The ideal treatment after orthodontics is to stabilize the arch segments on the new positions by means of fixed bridgework.

PATIENTS REQUIRING COMBINED PLASTIC SURGERY AND ORTHODONTICS

In extreme conditions, particularly those of bilateral complete cleft lip and palate which show gross facial and dental deformity, it is usual to restore the soft-tissue balance between the upper and lower lips before embarking upon orthodontic treatment. One method of achieving this is by the Abbé flap operation, where a segment of lip tissue is transferred from the lower lip into the upper lip. The profile photographs are those of a young patient aged 11 years, before treatment (*Fig.* 10) and two years after plastic surgery, which was performed by Mr. Eckhoff, and after the orthodontic treatment had been completed (*Fig.* 11).

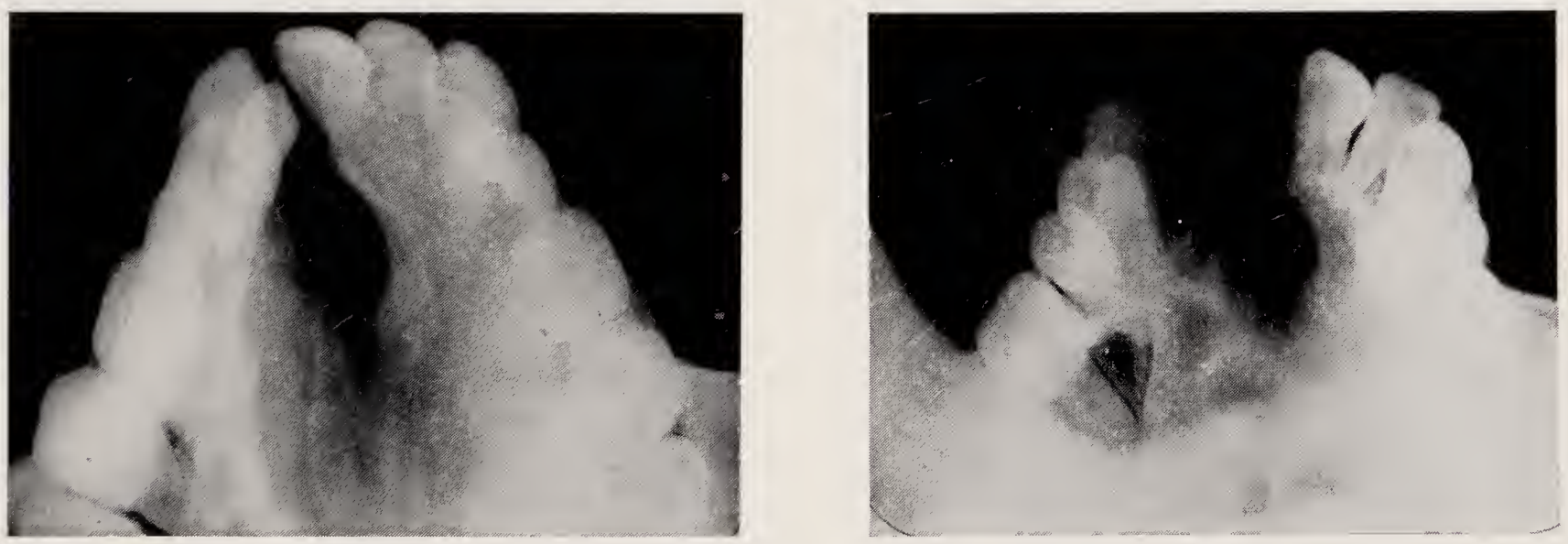

Fig. 9.—Occlusal radiographs : A, before, and B, after treatment.

The models show the marked dental deformity caused by a combination of many

Fig. 10.—Profile photograph of patient with repaired bilateral complete cleft lip and palate showing marked deformity resulting from deficiency of tissue in upper lip.

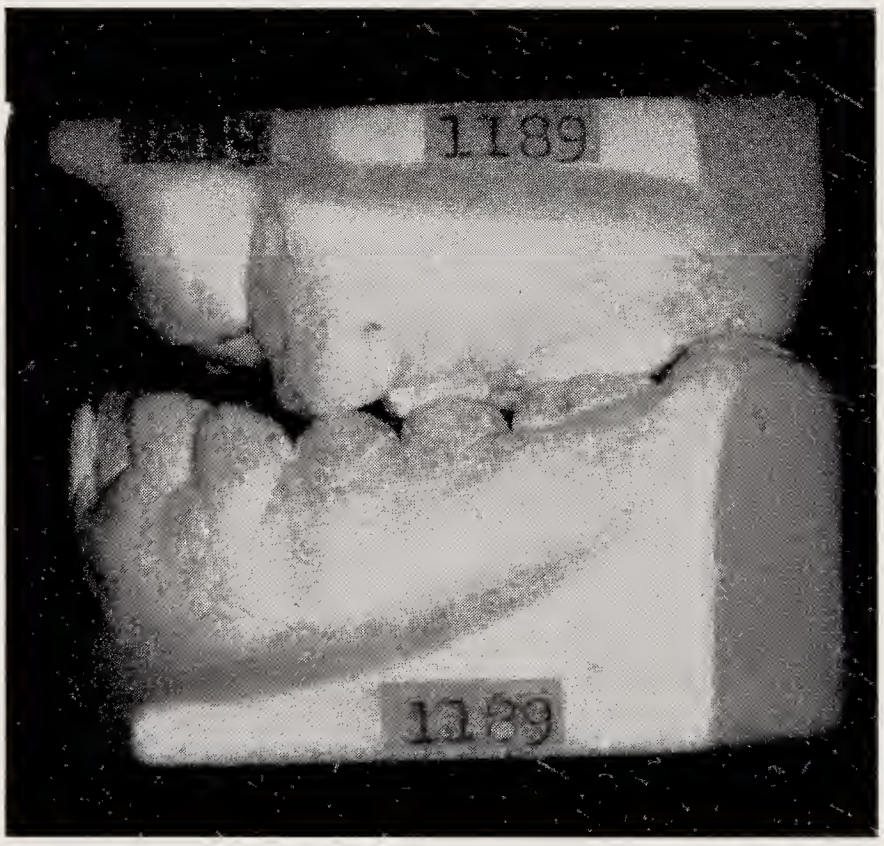

Fig. 12.—Model to show collapse of upper arch due to excessive pressure from upper lip.

adverse factors acting upon the development of the upper arch (*Fig.* 12).

1. Buccal segments are deflected medially.

2. The irregularity of the cheek teeth is probably due to the absence of the forward

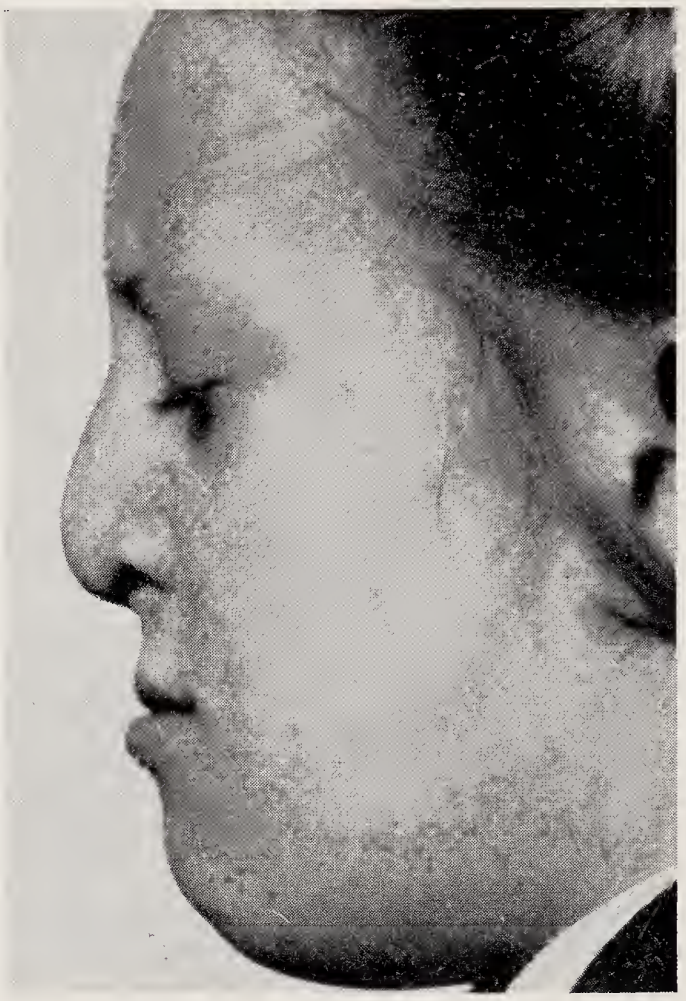

Fig. 11.—Profile photograph after Abbć operation.

development of the buccal segments combined with a failure in the vertical, downward, growth of the upper arch.

3. The anterior segment, which contains only one incisor tooth, has been deflected backwards by the contracted upper lip. The interaction of the tongue and immobile upper lip has also moved the incisor tooth until its incisal edge is pointed directly backwards.

The Appliance.—Immediately after the Abbé flap operation an appliance was constructed with bands on the first upper molars and on the incisor tooth. A Johnson's twin arch wire type of appliance was constructed, but with long tubes extended well forwards for greater stability. Coil springs acting between stops on the free sliding bow and the anchor bands produced a forward movement of the anterior segment (*Fig.* 13). The anterior segment was retained in a forward position by a palatal bow whilst the buccal segments were rotated laterally by fine wire springs as described earlier.

The models show the result of orthodontic treatment (*Fig.* 14). The segments of bone

now form the basic framework which provides the shape of the middle third of the face.

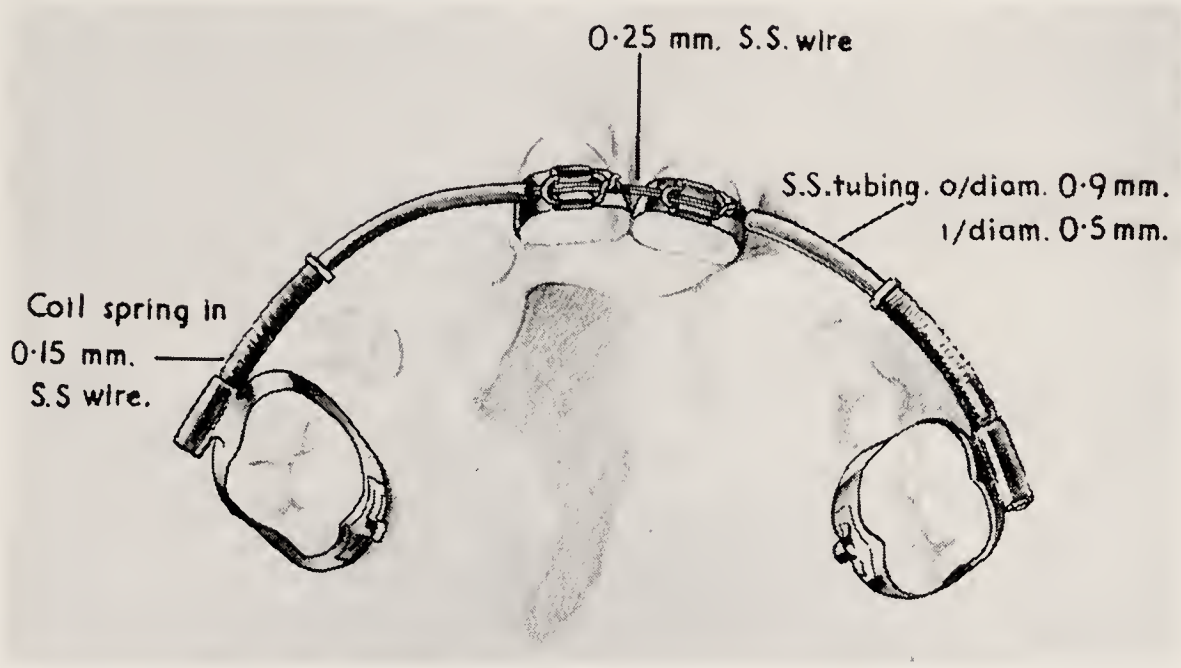

Fig. 13.—Type of appliance used to project incisors and prolabium forwards.

Lateral skull tracings show the manner in which the prolabium had been projected forwards. The arch segments must be retained in the new position by prosthesis.

Treatment of Dental Deformity following the Removal of the Premaxillary Element.—Where

Fig. 14.—After treatment with above appliance.

the bony element has been removed from the prolabium at an early age great dental and facial deformity results (*Fig.* 15). The upper lip is deficient in tissue and contracted. The removal of the bony support behind the lip results in a further inward contraction. There is also a considerable thickening of soft tissue inside the lip which fills up the space where the bone of the premaxilla should be situated. The face appears flat owing to the extreme

Fig. 15.—Gross facial deformity following removal of the prolabium.

medial displacement of the buccal segments (*Fig.* 16). This collapse is greater with the removal of the anterior segment, which allows

a medial deflection of the buccal segments until they achieve contaet in the midline. The aims of treatment are:—

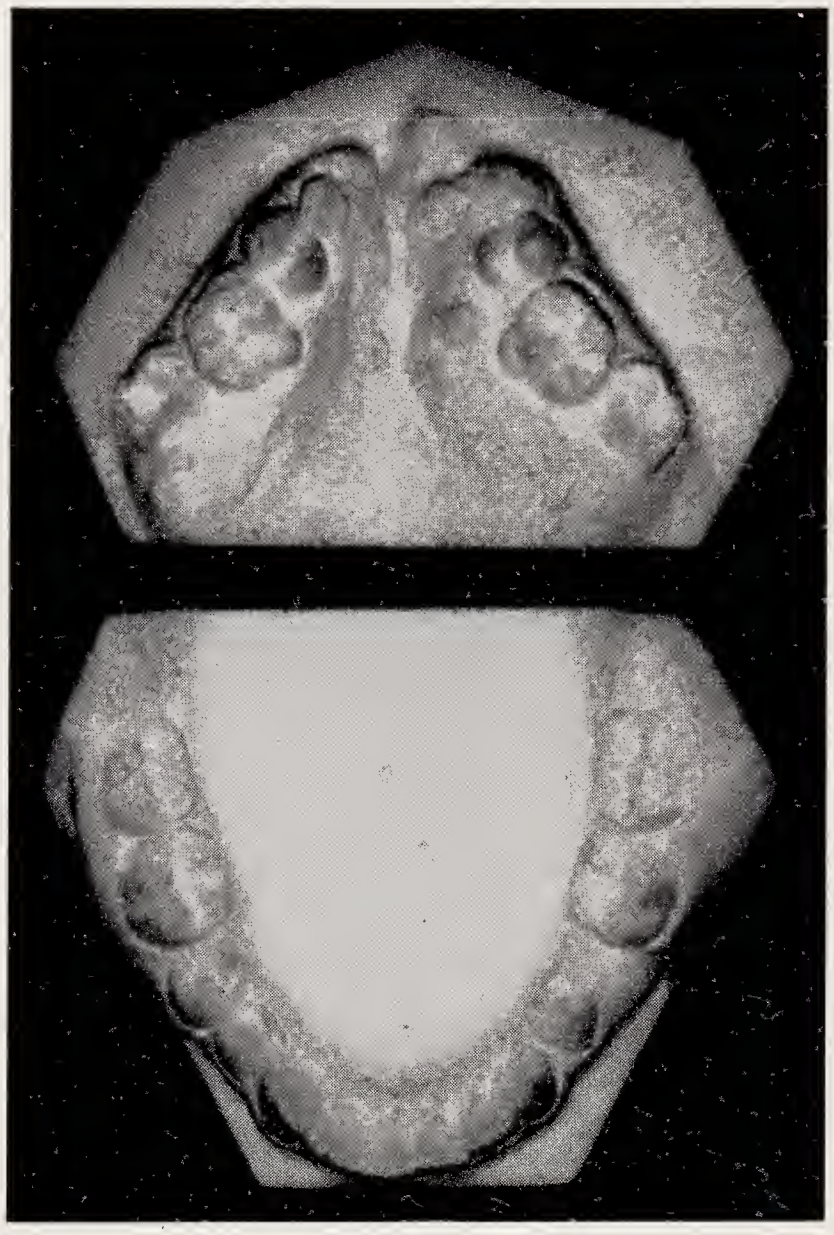

Fig. 16.—Marked medial rotation of buccal segments.

a. To widen the upper arch to improve the facial appearance and bring the cheek teeth into occlusal contact (*Fig.* 17).

b. To produce a better tissue balance between the two lips by surgery.

c. To construct a prosthesis to replace the missing anterior teeth and maintain the upper lip in a better position.

Orthodontic Treatment.—Orthodontic treatment was carried out with bands on the first upper permanent molars and canines. A soft 0·8-mm. S.S. W spring was used to move the buccal segments into better positions. Two lower premolars were extracted. This extensive movement is possible without producing a breakdown of scar tissue in the midline.

Occlusal X-rays show the degree of expansion. The use of tomographs will eventually allow us to determine whether new bone is laid down in the palate. On completion of orthodontic treatment in this case an Abbé flap operation was performed by Mr. Eckhoff. A profile photograph taken 1 month after operation shows the restoration of a better soft-tissue balance in the lips (*Fig.* 18). Prosthesis must be used to maintain the result.

THE VALUE OF ORTHODONTIC TREATMENT

Orthodontics has a very important place in the treatment of cleft-palate patients. Surgery alone cannot produce good results nor can orthodontics. A combination of surgery and orthodontic treatment from the onset is capable of producing better results than have been seen in the past.

A greater knowledge of the factors which produce dental deformity and the period of development in which particular influences are liable to cause irreparable damage will make it possible to mitigate their effect by the use of orthodontic treatment at the critical time.

Fig. 17.—Models showing result of expansion treatment.

My thanks are due to the Dental Council, Guy's Hospital, for providing facilities for the illustrations; to Mr. Eckhoff, Mr. Rix, and Mr. Pringle for permission to show certain of their cases under treatment at Guy's Hospital; to Miss Treadgold, of the Department of Medical Illustration, for the illustrations; to Miss Whitely of the Photographic Department, Dental School, Guy's Hospital, for the preparation of photographs and slides.

Fig. 18.—Profile photograph to show restoration of soft tissue balance by Abbé operation.

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IV. SECONDARY SURGICAL PROCEDURES FOR THE CORRECTION OF DEFORMITY IN THE CLEFT LIP AND PALATE PATIENT

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THE AETIOLOGY OF SECONDARY DEFORMITY

The deviation from normal which may be observed in an adult patient suffering from the defect of a cleft lip and/or palate which has been repaired in infancy will range from a minor variation in the contour and shape of the nose and upper lip with an insignificant alteration in the appearance and efficiency of the dentition, to a degree of deformity which can only be described as a mutilation.

The more severe examples are observed in those patients who have been subjected to operation by the relatively more traumatic techniques evolved during the latter part of the nineteenth century and the early part of the present century, but it is a matter for some regret that even to-day, employing improved and comparatively atraumatic procedures, many of the older patients originally born with a cleft lip and palate manifest a severe degree of interference in the normal growth and development of the facial skeleton.

It is not the purpose of this paper to consider the exact nature of the aetiology of such a deformity, but it is the author's contention that the original defect in utero is limited to a primary failure of mesenchymal growth and differentiation at approximately the sixth week of intra-uterine development which secondarily results in a breakdown of epithelial continuity, with a consequent establishment of a cleft, either in the lip or palate, or in both regions. This gap is subsequently widened by muscular pull assisted by tongue thrust, but the primary deformity is essentially limited to a variable degree of mesenchymal aplasia which persists for a relatively brief period of intra-uterine time. Thereafter, the parts continue to differentiate and grow at a normal rate and in a normal manner *unless they are subsequently interfered with by surgery*, so that the adult manifestation of an untreated cleft lip and palate will faithfully reproduce those conditions observed at birth when little or no interference can be detected in the relative proportions of the facial skeleton.

Whilst it is appreciated that closure of the lip at an early age is essential for social and psychological reasons, it is felt that palatal closure should be deferred until five years of age or later in order to minimize interference with the growth and development of the facial skeleton. It is therefore the author's desire to stress that the majority of secondary deformities are not in any way due to the original genetic defect, but are wholly or partially brought about by surgical intervention which may in some cases be both unavoidable and desirable, but may in other instances be a reflection upon the technique employed, and the timing of the operation in relation to skeletal growth and development.

SURGICAL PROCEDURES EMPLOYED IN THE CORRECTION OF THE SECONDARY DEFORMITY

The various methods employed for camouflaging or correcting the secondary deformities which become manifest in the cleft lip and palate patient during adolescence or early adult life may conveniently be considered in relation to six basic techniques:—

1. *The surgical revision* of existing tissues.
2. *Onlays*, inserted between the bone and the overlying tissues. These are preferably derived from autogenous sources and consist

Being the fourth contribution to a symposium at the meeting held on March 8, 1954.

of bone from the iliac crest or occasionally the olecranon process, or cartilage derived from the costochondral region of the eighth or ninth rib.

Homografts of preserved bone or cartilage, kept in merthiolate or a "deep-freeze", and derived from living or cadaver sources, may occasionally be employed. Heterografts of preserved bovine cartilage are also used and occasionally allelografts of polythene or terylene, but these latter substances are at the present time, to some extent, still in the experimental stage.

3. *Inlays* of epithelium obtained from autogenous split skin such as the Thiersch graft are frequently utilized to create a pocket for the insertion of a suitably shaped prosthesis by means of which the contour may be restored.

4. *The Abbé flap*: This technique employs a local rotation flap of full thickness from the lower lip which is used to fill a reconstituted defect in the upper lip.

5. *Maxillary osteotomy and bone-graft.*

6. *Tube pedicle repair of the palate*: This technique makes use of tissue imported from a distant source to close the defect in the palate. The procedure may or may not be performed in association with osteotomy of one or both maxillæ.

The last three techniques which have been enumerated are concerned with a fundamental principle of reconstructive surgery—placing back into normal position those structures which are normal, and transporting tissue from elsewhere to fill the original defect thus re-created.

1. The Surgical Revision of Existing Tissues.—This may be confined to the nasal and labial tissues, or the oral tissues, or surgical re-adjustment may be called for in both regions.

There is almost invariably some degree of lateral deviation of the premaxilla, anterior nasal spine, and base of the columella in the original deformity, and persistence of this abnormality frequently calls for repositioning of the alar base, narrowing of the nasal vestibule, and improvement in the contour of the nostril margins. Failure of downward and forward projection of the middle third of the facial skeleton will result in a disparity of growth between the upper and lower parts of the nose, so that the tip is commonly drooping and retroposed in addition to being deviated to one side. This appearance may be very considerably improved in most cases by submucous resection of the nasal septum, reduction of the prominent hump on the dorsum of the nose, and shortening of the septal cartilage comprising the nasal tip. In the case of a patient born with a bilateral cleft of the lip and palate there is an inherent shortage of tissue in the region of the columella, and it is usually necessary to lengthen this at some time subsequently by means of a V–Y advancement of tissue from the adjacent area of the upper lip. Lips which have been closed by some of the earlier techniques frequently appear either too short or too long, often with irregularity of the mucosal margins on each side of the line of junction of the two portions of the upper lip. Scar excision and re-adjustment of the level are then called for, and construction of the normal "cupid's-bow" may be effected by advancement of mucosa from the inner aspect of the lip.

Intra-orally, secondary surgical procedures are primarily directed towards the restoration of function. Minor oro-nasal fistulæ can usually be closed by means of local flaps of muco-periosteum from the palate. Gross shortage of tissue in the soft palate is often encountered, and it is not always appreciated that this occurs both in an anteroposterior and transverse direction, the previous attempt or attempts at closure having resulted in the formation of a considerable amount of residual scar tissue.

The edge of the soft palate is therefore some distance from the posterior pharyngeal wall, and in most instances repositioning cannot be attempted except by a bodily translation of the entire soft palate. Two principal procedures are used for this purpose, the Dorrance "push-back" operation, and the Gillies-Fry technique.

In the *Dorrance operation*, an extensive incision is made, starting on the palatal aspect of one maxillary tuberosity and proceeding a few millimetres from the palatal

aspect of the teeth, extending to a similar point on the opposite side of the upper jaw. The entire mucosa of the hard palate can then be elevated and the raw surface covered with a Thiersch graft. The flap is returned and pressure applied for a few days until the graft has taken. Three weeks later the flap, with its now epithelialized under-surface, is again raised, the attachment of the aponeurosis and nasal mucosa at the posterior edge of the palatine bones freed, and the entire soft palate displaced posteriorly, to be attached by its anterior margin to the posterior edge of the palatine bones.

The *Gillies-Fry procedure* divides the palatal mucosa, muscles of the soft palate, and nasal mucosa at the junction of the velum with the mucosa of the hard palate. This enables the soft palate to be displaced posteriorly as in the Dorrance procedure, but leaves a defect between the hard and soft palates which must be closed by an obturator.

Stenosis of the defect, with consequent retraction of the retroposed soft palate, is prevented by grafting the raw margins with a Thiersch graft.

Surgical procedures have also been devised by Wardill and Hyncs in an attempt to build up a cushion or pronounced form of Passavant's ridge on the posterior pharyngeal wall, a technique known as pharyngoplasty, a manœuvre which is designed, like the Dorrance and Gillies-Fry operations, to assist oronasal closure.

2. Onlays.—Contracture of the maxillary arches, owing to their imprisonment in a vice of scar tissue, may in turn interfere with normal growth of the facial skeleton which is reflected to some extent in a flattening of the bony prominence of the cheek. Onlay grafts to the underlying zygomatic bone will effectively restore the contour in such cases, the bone, cartilage, or other substance being inserted for preference via an incision placed within the hair line in the region of the temporal fossa. Onlay grafts may also be employed to correct the contour of the nasal bridge line, being inserted through a split-columella or intranasal paramarginal incision, or utilized to bring forward the region of the columella base. In some cases, bone-graft onlays have been inserted into tube pedicles for the reconstruction of the alveolar ridge.

3. Inlays.—A frequent and possibly inevitable sequel to the primary operation for the closure of a cleft lip and palate is the

Fig. 1.

Fig. 2.

Fig. 1.—Pre-operative profile, showing gross hypoplasia of the middle third of the face as a result of repeated attempts at palatal closure in infancy and early childhood.

Fig. 2.—Post-nasal epithelial inlay to permit insertion of prosthesis designed to bring forward the middle third of the facial tissues. The floor of the nasal cavity may be seen at the top of the picture.

formation of a variable amount of scar tissue in the upper labial sulcus. In addition there is usually some interference in the forward projection of the premaxilla. Satisfactory restoration of the lip contour may only be possible after the scar tissue has been excised and the abnormal attachment of the lip thus freed so that it may be held forward by a prosthesis, whether this be designed to fit over the existing anterior teeth or to replace them following their removal.

The simple excision of scar tissue is almost invariably inadequate since the raw surfaces adhere and further fibrous tissue formation is thereby promoted, and for this reason the pocket left following the excision of the scar must be lined with a thin layer of epithelial tissue. This is inserted, draped over an accurately fitting mould of black gutta-percha, which is supported by a detachable tray secured to a splint. The mould is left in situ for approximately one week post-operatively, when the graft will have attached itself to the underlying tissues. It will be

Fig. 3.—Prosthesis and obturator employed in this case.

evident that the extent to which the soft tissues of the lip can be translated in a forward direction will be dependent upon the degree to which the epithelial-lined pocket can be opened or distended, a factor which in turn is related to its width. Having due regard to the pronounced contracture from which all inlays of this nature suffer, it will be necessary to make the incision from the first molar region on one side to a similar point on the other side if anything more than a minor degree of forward movement of the lip is to be achieved. In most instances the dissection should extend to the level of the anterior nasal spine, but the pocket cannot be extended much beyond this point in a superior direction without perforating the nasal mucosa and creating a permanent oronasal fistula. This procedure may have to

Fig. 4.—Post-operative profile following insertion of bilateral onlay bone-grafts to the zygomatic bones, post-nasal inlay, insertion of prosthesis, nasal reduction, and bone-graft to dorsum of nose.

be done deliberately in those cases of severe deformity where the entire central section of the middle third of the facial skeleton is underdeveloped (*Figs.* 1–4).

4. The Abbé Flap.—The defect in the lip resulting from the failure of embryonic fusion may vary considerably from an incomplete cleft or fissure to a wide gap involving the floor of the nostril on one or both sides. This shortage of tissue, which is an inherent element of the deformity, assisted to a variable extent by the scar-tissue formation consequent upon operation, acts as a tight restrictive band which effectively prevents the development of the normal basic pattern of skeletogenesis, particularly with regard to the dento-alveolar component of the middle third of the facial skeleton.

The mandible and tissues of the lower lip are not thus restricted and occupy a position which approximates to normal, although the the case. Any attempt at a lip seal results in the tight upper lip pressing on to the posterior aspect of the mucosal border of the

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 5.—Bilateral cleft lip and palate closed in infaney.

Fig. 6.—Profile view.

Fig. 7.—Full-thickness flap from lower lip rotated into position in the upper lip, in whieh the original defect has been re-created.

Fig. 8.—Appearance five years later.

Fig. 9.—Note restoration of normal profile.

increased vertical depth of the unopposed lower alveolar segment tends to carry the lower lip level slightly higher than is usually lower lip, and the presence of an increased free-way space, which is an almost invariable accompaniment of such cases, together with

malposition of the incisor teeth, encourages forward thrust of the tongue against the lip during deglutition. The resultant drooping and eversion of the lower lip is further encouraged by the lack of muscular continuity of the orbicularis oris which is in consequence unable to exercise its normal sphincter action so that there is a lack of balance with over-activity of the fibres of the lower lip.

Fig. 10.—The continuous line indicates the level of division of the mucoperiosteum and the interrupted line, the level of division of the lateral wall of the maxillæ.

The Abbé operation is a logical procedure designed to transpose a whole-thickness wedge of tissue from the lower lip into the upper lip after the original defect has been surgically reconstituted by excision of the scar.

The excellent vascularity of the facial region makes it possible for a V-shaped or W-shaped full-thickness flap of skin, muscle, and mucosa from the lower lip, the final division of which just stops short of the mucosal margin on one side so as to include the inferior labial artery, to be rotated on this remaining attachment through 180° into the re-created defect in the upper lip, where the various layers of tissue are meticulously sutured into position. There is a sufficient residual surplus of tissue in the lower lip in such cases to permit direct closure of the subsequent defect without undue tension or diminution in the oral vestibule. After fourteen days the circulation has become sufficiently established to allow the flap to be detached from the lower lip, when the margins may be finally trimmed.

Fig. 11.—The maxillæ, after osteotomy, are placed into their correct lateral relationship with the mandible by attaching the locking plates and connecting bar.

Thus, in one procedure, the ugly eversion of the lower lip is corrected; the tension of the upper lip on the upper jaw relieved; and a restoration of soft tissue and muscular balance between the upper and lower lip obtained. Where such a procedure is clearly indicated it would seem to be reasonable and

advantageous for the operation to be carried out before undue restriction of maxillary growth occurs, although some degree of co-operation from the younger patient must be ensured, particularly during the intermediate stage. Interdental eyelet wiring is often a wise precaution during this phase of

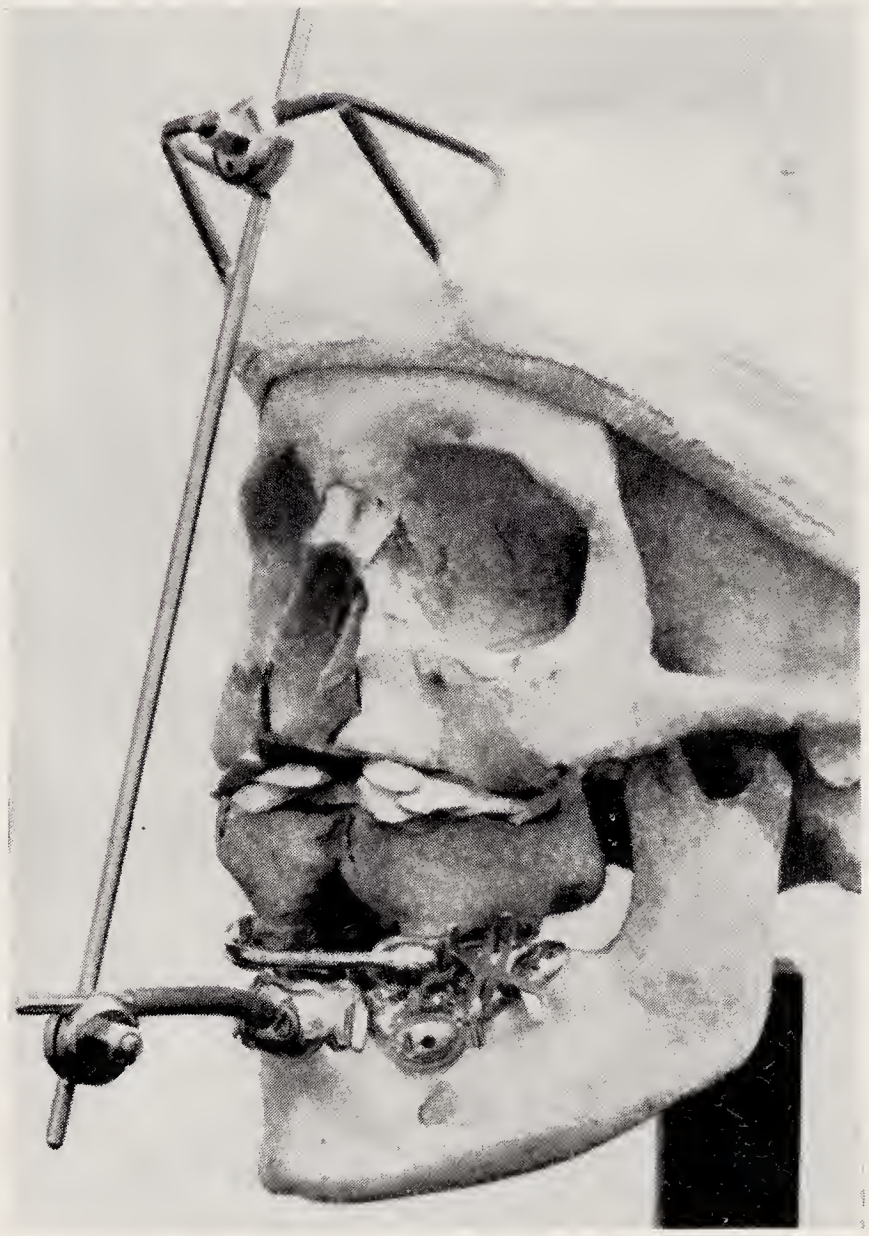


Fig. 12.—Cancellous chip bone-grafts in position prior to closure of the mucoperiosteum. Craniomandibular fixation has been applied.

treatment to prevent opening of the jaws with consequent tearing apart of the tissues (*Figs.* 5–9).

5. Maxillary Osteotomy.—Although the provision of orthodontic treatment may largely counteract the less severely contracted types of arch deformity in the upper jaw, the extreme narrowing of the apical base encountered in many cases must render the future stability of the tooth position somewhat insecure; and in the adult patient there would seem to be little doubt that effective repositioning of the teeth or the maxillary segments as a whole cannot be achieved by this means.

Until recently there was little that could be offered such patients apart from a somewhat unstable type of prosthesis, but the original

Fig. 13.—Maxillary hypoplasia with associated contracture of the arch in a Veau III type of cleft lip and palate repaired in infancy.

work of Sir Harold Gillies in the field of maxillary osteotomy for the adult cleft-palate patient has enabled a different approach to be made to the problem. Experience in osteotomy

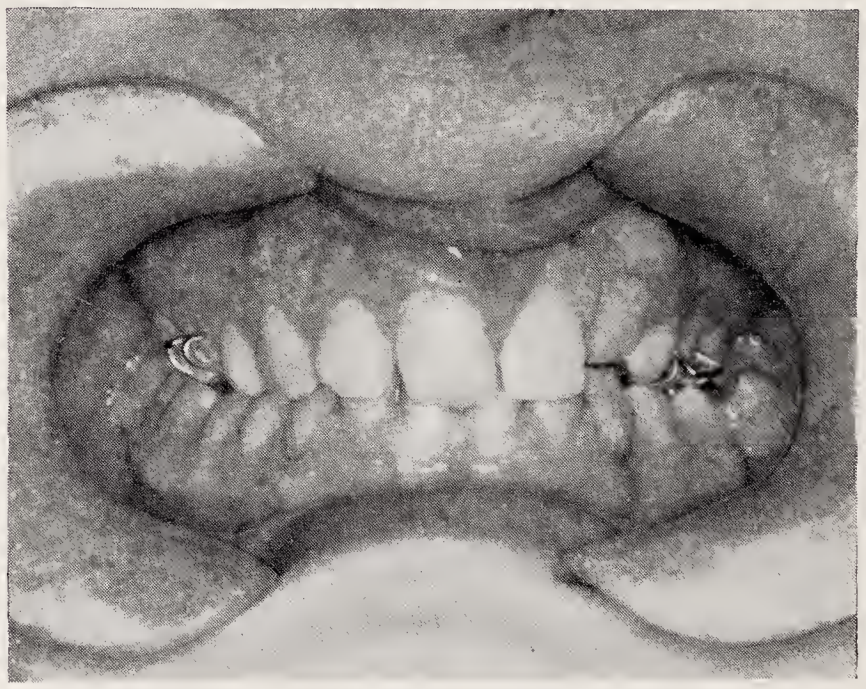


Fig. 14.—The dentition of the patient shown in *Fig.* 13 after maxillary osteotomy with forward translation of the right segment. Further improvement will be made by extracting $\underline{|3}$ and constructing a partial denture.

of the upper jaw for various conditions arising from untreated injury to the middle third of the facial skeleton, and divers congenital deformities of the skull and facial bones, resulted in the application of the knowledge

gained in this way to the residual deformity of the arch in cases of cleft lip and palate.

The principles of the procedure consist essentially in sectioning of the lateral wall of the maxilla, fracture by instrumental leverage of the tuberosity, pterygoid laminæ of the sphenoid bone, and medial wall of the maxilla, jaws are one integral unit (*Fig.* 11) and this combined maxillary/mandibular block is then placed in its correct position in relation to the cranial base. This is achieved by pre-operative assessment of the resting position of the mandible, using the position of the anterior projecting bar from the lower splint in relation

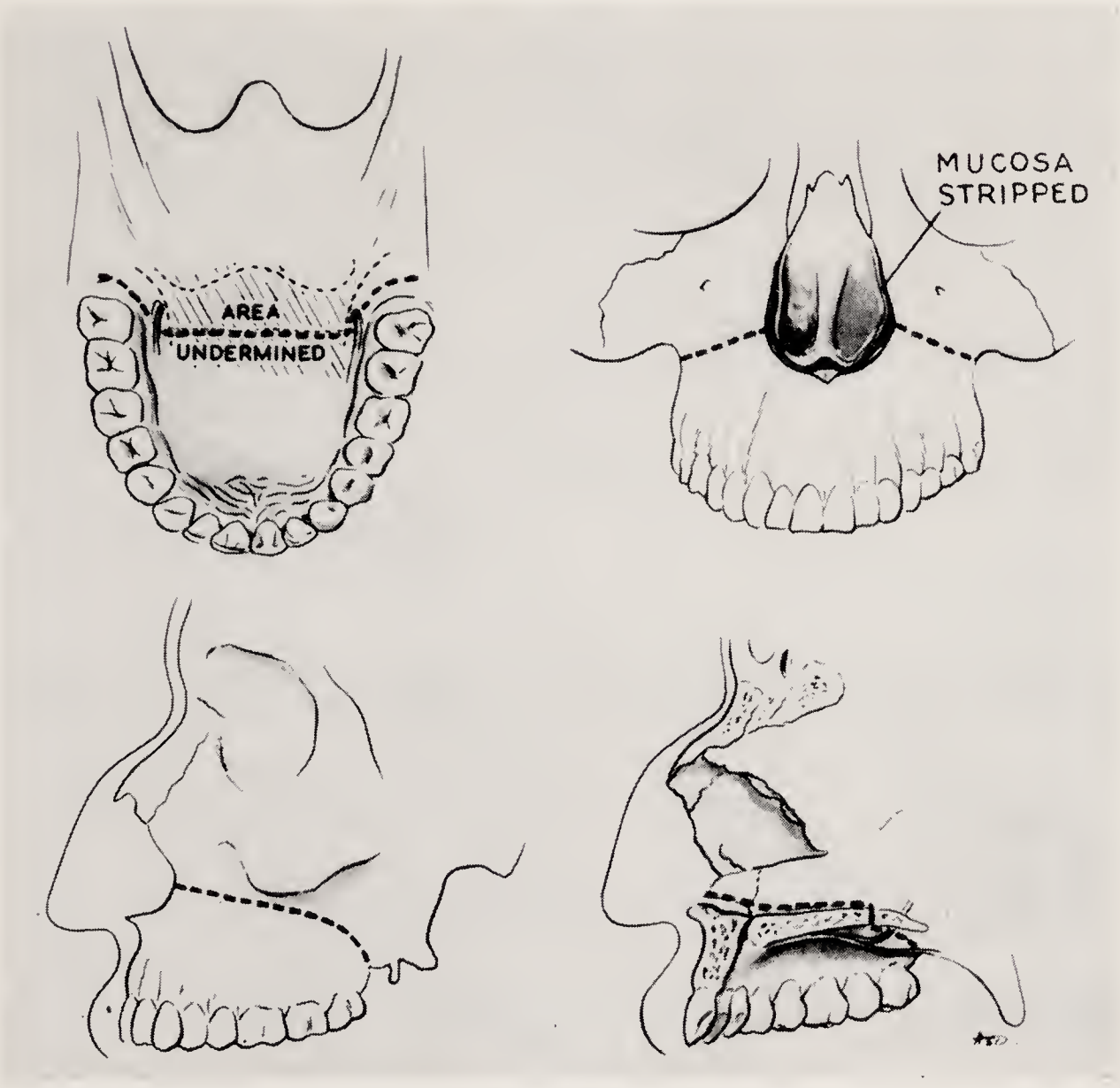


Fig. 15.—Maxillary osteotomy. Diagram illustrating the lines of section employed when an antero-posterior movement of the maxillæ is indicated. The division is suitably modified when only one maxilla is involved.

and reposition of the dento-alveolar component into a position of optimum occlusion with the lower teeth (*Fig.* 10). Fixation is provided by cast silver/copper alloy cap splints on both upper and lower jaws, the degree of separation of the maxillary segments being controlled by screwing into position a previously constructed connecting bar soldered between two locking plates, the width of the bar being determined beforehand by careful laboratory calculations with the aid of study models.

The maxillary splints, after fixation of the pre-arranged connecting bar, are secured to the lower splint by elastic bands so that both to the vertical rod employed for cranio-mandibular fixation to a plaster-of-Paris headcap as a point of reference; this being recognized at operation by small locating file-marks on the rod, projecting bar, and headcap framework.

When the connecting bar between the two halves of the upper jaw has been screwed into place, the maxillæ immobilized to the mandible, and the mandible in turn secured by universal joints to the headcap framework via the anterior projecting bar and vertical rod, a gap will have been defined between the upper and lower cut edges of the lateral walls of the

maxillæ. It is widely recognized that the freeway space in previously operated cleft-palate patients is greatly increased, and as a result of correction of this factor the gap ensuing after stabilization of the mandibular/maxillary component to the headcap is often appreciable. This must be filled with chips

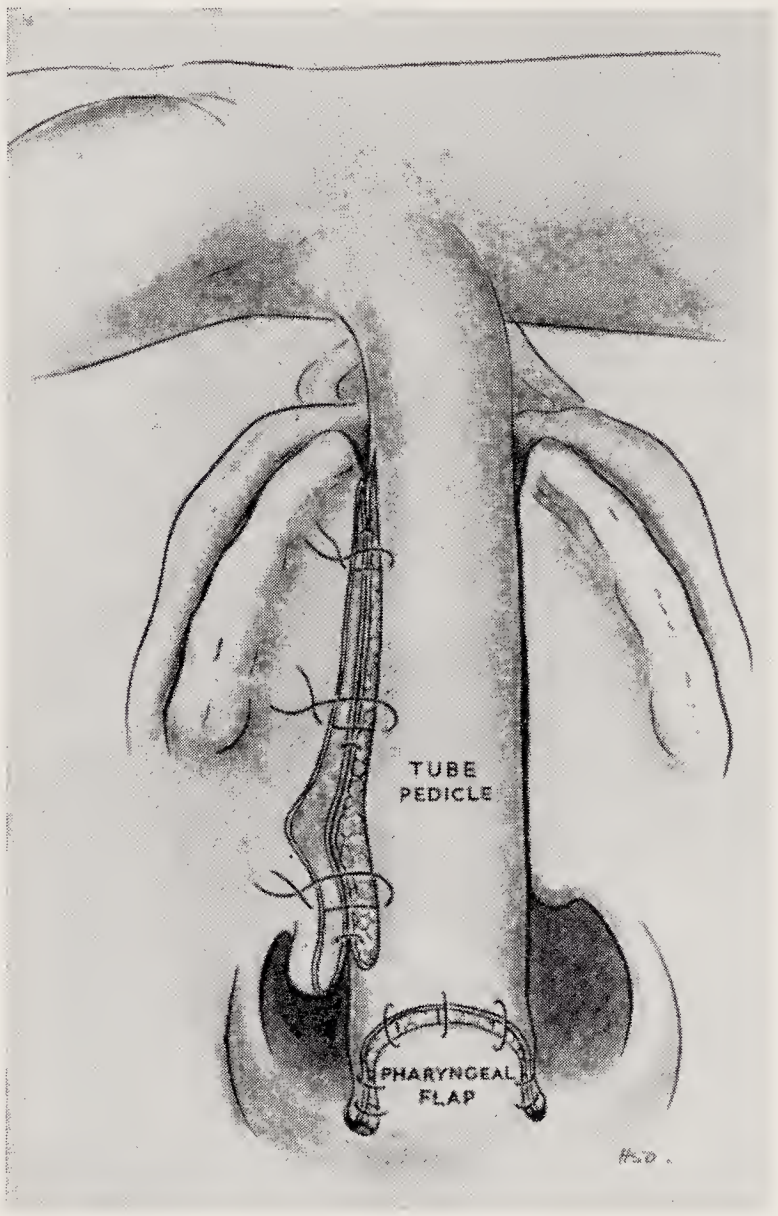


Fig. 16.—The tube pedicle, carried on the wrist, is attached to the flap on the posterior pharyngeal wall, and the margin of the palatal cleft.

of cancellous bone from the iliac crest if relapse is to be prevented post-operatively (*Fig.* 12).

Infection of the graft from the antrum is prevented by antibiotics aided by a good blood-supply from the mucoperiosteum. Craniomandibular fixation is maintained for four weeks, following which the headcap and maxillary/mandibular fixation is removed. The connecting bar between the two halves of the upper jaw is, however, retained for a further eight weeks, making three months in all.

The centripetal inclination of the lower teeth is a factor encouraging relapse of the fragments, and careful selective grinding of the buccal cusps of the lower posterior teeth is usually indicated, so that the axis of masticatory force may be directed through the vertical axes of the upper teeth.

It will be obvious that no movement can occur if one maxilla is attached to the nasal septum, but this greater fragment in many cases being the least affected by the contractile forces, does not usually require re-orientation.

However, should this be required the procedure is easily achieved by submucous division of the septum from the maxilla.

Anteroposterior movement of the entire upper jaw or part of the jaw can be performed, but besides the line of section previously described, transverse division of the palatine processes of the maxillæ in addition to division of the septum will be required, with special care being taken, as in all cases of maxillary osteotomy, to preserve the blood-supply through the palatine artery (*Figs.* 13–15).

6. Tube Pedicle Repair.—This procedure may be indicated under the following circumstances:—

a. As a complementary procedure for the repair of a lip and/or anterior palatal defect following maxillary osteotomy.

b. To close the defect between the hard and soft palates following the Gillies-Fry operation.

c. When the cleft in the hard and soft palates has not been previously closed surgically, and there is inadequate local palatal tissue, a tube pedicle may be inserted and attached to a flap dissected up from the posterior pharyngeal wall and the freshened margins of the palatal cleft (*Fig.* 16). Following detachment from its carrier, the pedicle then functions partly as a surgically constructed obturator of warm living tissue, and partly as a median raphé against which the lateral elements of the soft palate can approximate themselves and close the aperture of the nasopharynx, which is now divided into two separate channels on either side of the pharyngeal insertion of the pedicle.

Where the muscular action of the soft palate is seriously impeded by lateral tension from scar-tissue contracture and deficiency of

tissue, division in the midline can be performed, and a tube pedicle inserted on to the posterior pharyngeal wall between the lateral halves of the sectioned velum.

Fig. 17.—Tube pedicle repair of palate. The pedicle was originally inserted into the inner aspect of the upper lip and is here shown after detachment of the other end, which has been attached to the pharyngeal wall and margins of the palatal cleft.

The tube pedicle itself may be raised from the acromiothoracic region, the abdomen, or the inner aspect of the upper arm, and transferred either directly, or via the wrist as an intermediate carrier, being inserted directly into the pharyngeal wall and one-half of the maxilla along the free margin of the cleft. The pedicle may also be inserted as an intermediate measure into the inner aspect of the lip (*Fig.* 17), or a reconstituted defect in the upper lip. Other routes have been described anteriorly through the nasolabial fold of the cheek by Schuchardt, or posteriorly just in front of the masseter muscle by Kitlowski.

Fig. 18.—The tube pedicle, transported on the wrist, has in this case been inserted directly into the pharyngeal wall. Note the supporting lateral struts keeping the jaws apart, thus preventing trauma to the pedicle.

During the period of insertion of the tube pedicle, the jaws must be kept widely separated by lateral supporting struts to prevent any risk of trauma when the pedicle is gaining attachment to the tissues. If the operation has been preceded some months beforehand by a maxillary osteotomy, the same splints may be utilized, otherwise they must be specially constructed for the purpose (*Fig.* 18). Both before and after detachment of the pedicle from its intra-oral insertion, relief of gravitational pull should be afforded by a support attached to the upper splint, and finally some controlled degree of compression to the tissues of the mature pedicle will materially assist in improving the contour of the palatal vault (*Fig.* 19).

In conclusion, it should be stressed that the best results in the majority of patients suffering from secondary deformities of the cleft lip and palate can only be obtained from the combined services of the plastic surgeon, oral surgeon, orthodontist, prosthodontist, and speech therapist working together as a combined team aided by the determined and intelligent application of the patient to his or her particular problem.

Acknowledgements.—The author is grateful to Sir Harold Gillies, C.B.E., F.R.C.S., for permission to include *Figs.* 5–9, which form part of the illustrations from his forthcoming book on plastic surgery, written in conjunction with Ralph Millard, M.D., and to be published by Littlebrown & Co., of Boston, U.S.A.

Figs. 17–19 are from cases performed in conjunction with Sir Harold Gillies, and *Figs.* 1–4 from a case in association with Mr. W. G. Holdsworth, F.R.C.S.

Figs. 13 and 14 relate to a case admitted under the care of Sir Harold Gillies and operated upon in conjunction with Mr. A. J. Evans, F.R.C.S.

Figs. 15 and 16 were drawn by Capt. H. Sibson Drury, Medical Artist to Rooksdown House, and the photographs were taken by Mr. E. Ferrill and Mr. R. Burn, of the Department of Medical Photography.

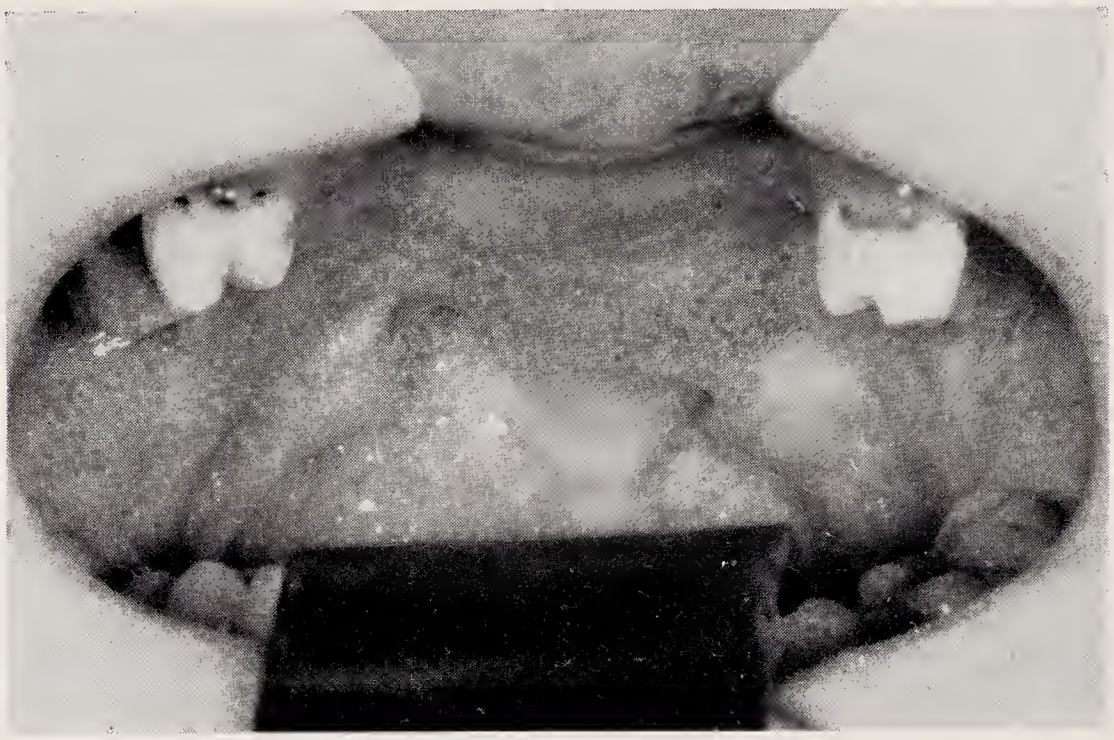


Fig. 19.—The same patient as shown in *Fig.* 18 after detachment of the pedicle and insertion into the upper lip. Note the point of attachment to the posterior pharyngeal wall.

DISCUSSION

[The Discussion following the Papers given by Mr. M. A. Kettle and Mr. N. L. Rowe.]

Mr. K. E. Pringle, in opening the discussion, referred to the work of Dr. Harvold of Oslo and said that he was grateful to the London Hospital for giving him the opportunity of hearing him speak of his work a few years ago, because until then he had no idea that orthodontic treatment could open up cleft palates. He would like to ask Mr. Kettle, who had shown such excellent results, whether he thought that early orthodontic treatment to open up the maxillary cleft was essential because of speech, or whether it could be left until later. He would also like to ask Mr. Kettle how much time the orthodontist should spend in straightening and alining incisors if in the end some form of bridge would be necessary. Overlong orthodontic treatment was to be avoided if possible.

Mr. Rowe had given him new hope as he had shown that if the surgeon could keep away from the palate the orthodontist would not have so much to do.

He would like to ask Mr. Rowe what was his view of the Abbé operation when done in a child of 5 or 6, which was the age Mr. Kettle suggested the operation should be done? How, after the operation, would he prevent the child from opening the mouth? Interdental wiring was not very easy at that age, and splinting difficult. Did he (Mr. Rowe) use splints? Did he prop the mouth open?

Finally, he would like to suggest to the meeting that those who wished for an easy life in orthodontics should leave cleft palate cases alone.

Mr. J. C. Ritchie said that both Mr. Kettle and Mr. Rowe had mentioned the McNeil technique, and he would like to show a few slides demonstrating the success he had had with it.

Mr. Ritchie then showed several slides in which the McNeil technique had stimulated the soft-tissue closure or reduction of the cleft opening in a relatively short time, both in operated and non-operated cases.

He wished to thank Dr. Hansell, of Westminster Hospital, and Mr. Martin, of Great Ormond Street Hospital, for their help in the preparation of the slides.

Mr. J. P. Reidy said that, as a plastic surgeon, he would like to make a few remarks.

He said there had been a great deal of overstatement at the present meeting. Much was out of perspective and somewhat biased. All the bad results had been attributed to plastic surgeons, and he was sure that many of the cases had never been treated by a plastic surgeon. Some of the cases shown must have been treated in 1936 or 1937 or earlier, when there were only two plastic surgeons in the country and they were not able to cope with all the work. Some of the cases were thirty years old, and it was quite evident to him that they had not been operated on by Sir Harold Gillies or Professor Kilner.

Mr. Kettle talked about unsatisfactory results without saying anything about the type of operation that had been done. Most plastic surgeons now did the V and Y operation which was based on the work of Veau, but no-one had mentioned that at the present meeting.

Mr. Reidy said that there had been a great deal of misuse of terms, and he found that very misleading. Mr. Kettle had talked about the complete cleft. Other speakers had talked about Veau 1, 2, 3, and 4. He did not know what this meant. Davis and Ritchie had devised (about 1926) a nomenclature for cleft palates which most plastic surgeons used, as follows: Group 1, cleft of soft tissue of lip only (purely cosmetic); Group 2, cleft palate from the nasal palatine foramen running posteriorly to the uvula. Repair of clefts in Groups 1 and 2 very rarely concerned orthodontists because there was no collapse of the alveolus if done by a trained plastic surgeon. Group 3 consisted of alveolar clefts, that is, clefts of lips, alveolus, and palate. These were sometimes called "complete" by orthodontists.

Flattening occurred in the alveolus in the case of alveolar clefts even without an operation. He thought, therefore, that flattening could not be always attributed to the general surgeon or the plastic surgeon who might or might not have operated on the case.

A slide had been shown of the Abbé flap operation on a unilateral alveolar cleft. He thought he was speaking with the authority of Professor Kilner when he said that there was no indication for such an operation on a unilateral alveolar cleft because there was no loss of tissue. Its general use was in the cases of bilateral cleft to relieve the tight upper lip.

Reference had been made to doing the Abbé operation at 5 years of age. He agreed that there was no technical difficulty, but there was no point in it. It should be done from 7 years of age upwards, perhaps as late as 12 years of age. In young children there were difficulties of splinting and feeding.

Mr. Reidy then said that he was very sceptical about the question of stimulation in closing clefts. He thought that stimulation would first produce inflammation, then fibrosis, and then a form of hypertrophy. It was not a good substitute for adequate surgery. He would suggest that the surgery which Mr. Rowe had shown was not a cross-section from an ordinary unit. It was very dramatic and highly successful, but it did not commonly occur.

With regard to the age at which to operate on a cleft palate, it was Professor Kilner's teaching that this should be done at or about the first birthday.

He was sorry to see the influence of the American schools on some of the speakers because it was his own experience that American plastic surgery lagged behind British plastic surgery in this particular field.

Mr. Reidy said that he thought that the "deformity" of a speech defect was very much greater than the deformity of the collapsed arch, and that the latter was much easier to correct than that of cleft palate speech which had been allowed to go on for several years. Moreover, the psychological effect on the child was greater with a speech deformity.

Miss J. H. Van Thal said reference had been made to speech therapists in the team to deal with cases of cleft

palate, so she would like to make a small contribution, and said that a child could learn a foreign language perfectly up to 5 years of age, but how many could do so after that age? The maximum imitative drive is present before 5 years of age; after that it decreases to a minimum and the aequisition of entirely new speech habits could only be achieved by people of exeeptional intelligence and nervous stability with a gift for languages. How could one know if these assets were to be found in a child before 5 years of age? Had we the right, in the meantime, to subject them to the humiliation of being unablc to communicate with others?

Mr. M. A. Kettle in replying to the discussion, said that he thought the best time to commence orthodontic treatment for cleft palate cases was when the permanent upper incisors were erupting. It depended on the eo-operation of the patient. If it was left until later he thought a good deal was lost owing to the collapse of the arehes preventing normal development. He regarded speech as the most important thing that had to be considered, and that was one of the reasons why he advocated early operation on the palate.

With regard to irregular upper incisors, he usually found that as one expanded the arch these tended to aline themselves and so make complicated treatment unneeessary. If bridge-work would be used ultimately, the important thing was to get the axial inclination of the teeth into proper alinement.

He thanked Mr. Reidy for his remarks, and said that it was a pity he had not been present at the previous meeting because many of his questions were answered then. Mr. Kettle said that he had said in the previous meeting that he advocated early operation beeause the main anteroposterior increase in the length of the palate took place between the ages of 5 and 10 years, and it was important that no operative interference occurred at this time. He disagreed in this respect with Mr. Rowe because he thought that speech was more important than appearance.

Mr. Reidy had aecused him of produeing incomplete data, but again, if he had been present at the previous meeting he would probably not have done so.

Mr. Kettle thought that it was nonsense to say, as Mr. Reidy had, that no collapse of the alveolar arch occurred if the operation was properly done. He thought that it would be an advantage if Mr. Reidy was more acquainted with the orthodontist's work.

He was in full agreement with Miss Van Thal.

Mr. N. L. Rowe said that on the question of doing an Abbé flap operation at the age of 5 or 6 years he agreed with Mr. Reidy that it was unneeessarily early for it, but he did not agree that fixation was really difficult. It could be done satisfaetorily with interdental eyelet wiring but if there was any difficulty in this a cap splint could be used.

He did not prop the mouth open. The child could feed quite well without it.

Mr. Reidy had accused him of bias. He agreed that he had shown the worst cases, but he had done that to make his point. He said that any consideration of the problem must take into account the variations of degree of the original congenital deformity and the fact that there was no single standard of surgical skill, even though the operative proeedure might be identieal.

Mr. Rowe continued by saying that he was astonished that Mr. Reidy had never heard of the Veau classification, which he thought was the most useful one.

He agreed that he had shown cases of adults that had been operated on 20 or 30 years ago when there werc few plastie surgeons, but he had also shown cases of children of 4, 7, about 9, and 12 years of age, with appreciable defeets in the growth pattern of the facial skeleton, which had eertainly been operated on by plastic surgeons. He would ask Mr. Reidy to remember that the cases which he was seeing now, possibly at 7 or 8 years of age, might show a greater dcformity when they reached maturity.

VARIATIONS OF THE MODIFIED ARROWHEAD CLASP

By **C. P. ADAMS**, B.D.S., F.D.S.

THE modified arrowhead clasp (Adams, 1950, 1953) can be used to clasp any tooth, deciduous or permanent, and has been found efficient in the retention of all types of removable appliance.

From time to time, however, variations of the design, and extensions of the use of the clasp have been suggested and tried out. It would seem timely, therefore, to describe and illustrate some of the special varieties of the clasp that are now in general use.

Canines and Deciduous Molars.—*Figs.* 1 and 2 show the construction of the clasp for deciduous molars and canines. For canines, 0·6-mm. wire is best, as it is sufficiently strong and can be well fitted into the groove between the canine and the adjoining teeth on the lingual side (*Fig.* 3), so avoiding the bite of the lower incisors. For deciduous molars 0·7-mm. wire is used. The clasp must be very carefully made on account of the shallowness of the crowns of these teeth, otherwise the tags of the clasps may not lie closely enough in the embrasure between the marginal ridges, and interfere unnecessarily with the occlusion.

Fig. 1.—For deciduous molars do not make the clasp too wide, keep tags well down on the embrasures.

Figs. 2, 3.—For canines use 0·6-mm. wire and fit the tags well down between the teeth on the lingual side.

Rotated Teeth.—If the tooth to be clasped is rotated (*Fig.* 4), the clasp is applied exactly as if the tooth were in normal position. That is to say, the bridge between the arrowheads is kept parallel to the general line of the arch and is not rotated so as to remain parallel to the buccal surface of the tooth. The reasons for this are, firstly, while one undercut of the tooth has rotated out of sight and reach, the other has become more accessible and an excellent grip can be obtained on it with one arrowhead, while the other arrowhead, if not

A demonstration at the meeting held on May 10, 1954.

perhaps having an undercut to grip, still impinges on the tooth and stabilizes the clasp as a whole. Secondly, to rotate the clasp

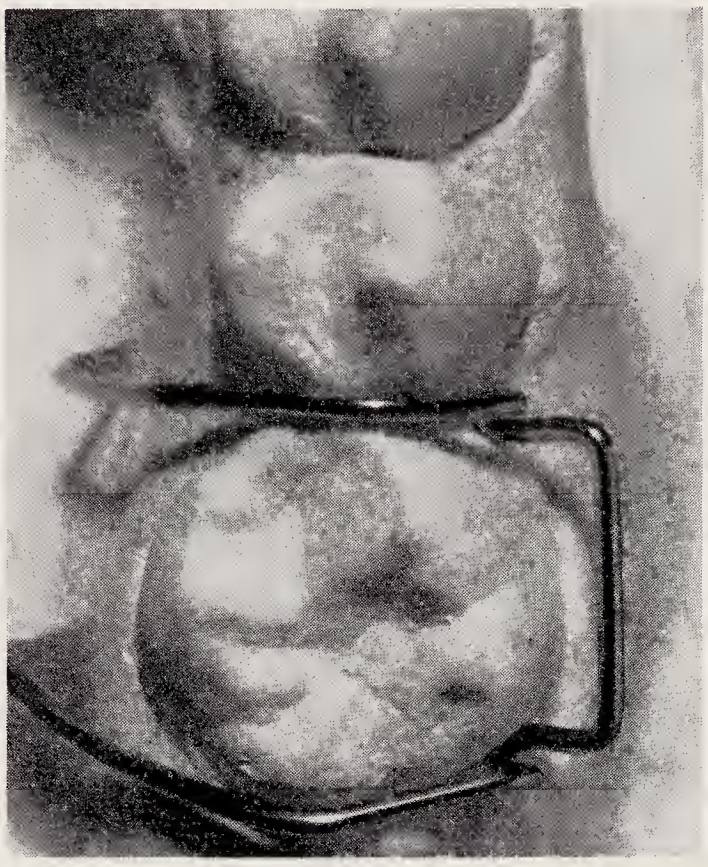


Fig. 4.—When clasping a rotated tooth keep the bridge parallel to the line of the arch.

involves the risk of bringing one arrowhead into contact with the tooth adjoining.

Traction Hooks.—Intermaxillary traction hooks may be either incorporated in the bending of the clasp or else welded or soldered to the normal type of clasp later on. *Fig.* 5 shows standard traction hooks incorporated in the bending of the clasp. These have the merits of strength and ease of construction, and require no welding or soldering. *Fig.* 6 is the same hook on an upper first premolar. If the sulcus is shallow behind and below a lower tooth, as sometimes happens with a lower first permanent molar, it is not feasible to use this form of hook, as it is inclined to project into the soft tissue where it is reflected from the alveolar process at the bottom of the sulcus.

The alternatives are shown in *Fig.* 7, a simple turn in the bridge over or through which the elastic is looped, or the hook in *Fig.* 8 A, which may be soldered or welded using 0·7-mm. soft wire. The free end of this hook should be turned in under the bridge of the clasp (*Fig.* 8 B) to avoid irritating the soft tissue of the cheek.

Often in place of an upper traction hook, it is convenient to loop the elastic over the bridge of a plain clasp before the plate is inserted and the other end of the elastic is hooked in the ordinary way on to a hook on the lower clasp.

The Single Arrowhead.—Where the last tooth in the lower arch is semi-erupted, as often occurs with a first permanent molar at 6 to 7 years of age, or a second permanent molar at 11 or 12 years of age, the distal undercut is not accessible, and on that account the distal arrowhead is omitted. The mesial arrowhead, however, in conjunction with a

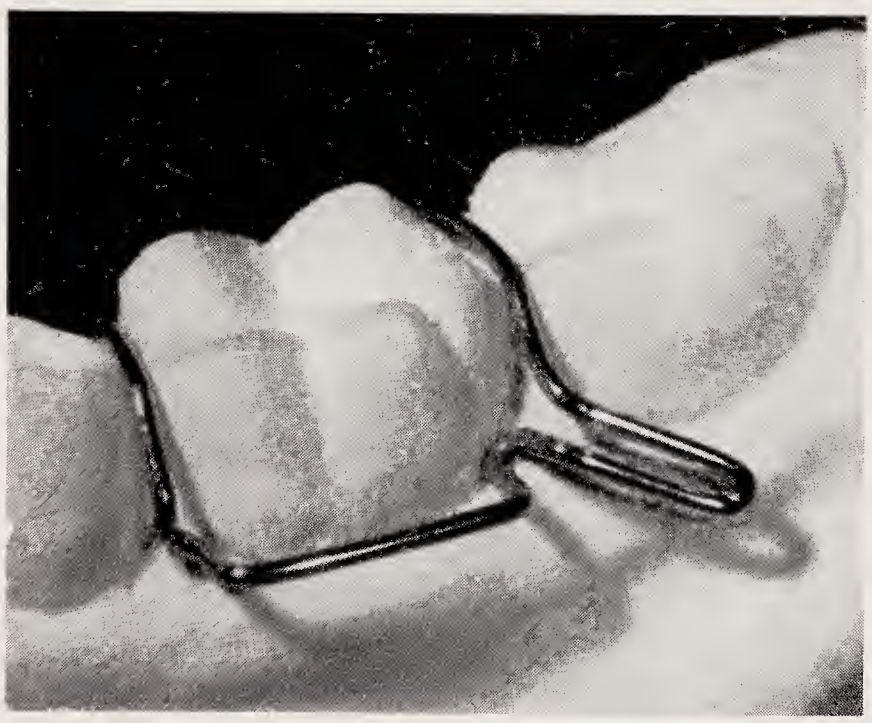


Fig. 5.—The standard lower posterior traction hook. Very strong, simple to construct.

Fig. 6.—The standard upper anterior traction hook.

clasp on a premolar farther forward, provides valuable retention (*Fig.* 9).

Fig. 7.—The loop hook for a shallow sulcus. No welding or soldering required.

The Accessory Arrowhead.—Where utmost retention is required and two teeth on one side separated from one another by a space or by a third tooth are not available, two adjoining teeth may be clasped using the accessory arrowhead. *Figs.* 10 and 11 show this clasp, constructed for use on $\overline{6E}|$ in *Fig.* 10 and for $|\underline{56}$ in *Fig.* 11, where it was desired to have very firm retention of the plate and to move $|\underline{4}$. The free tag of the accessory arrowhead is welded or soldered to the bridge of the main arrowhead after the plate is processed. Before this soldering or welding is done, the appliance should be tried in and the accessory arrowhead should be checked for accuracy of fit.

The practice of putting modified arrowhead clasps on two adjoining teeth which are in contact with one another must be condemned. Such clasps cannot be fully effective, or easily adjusted, and it is rarely desirable to have two tags passing over the same contact point.

A B

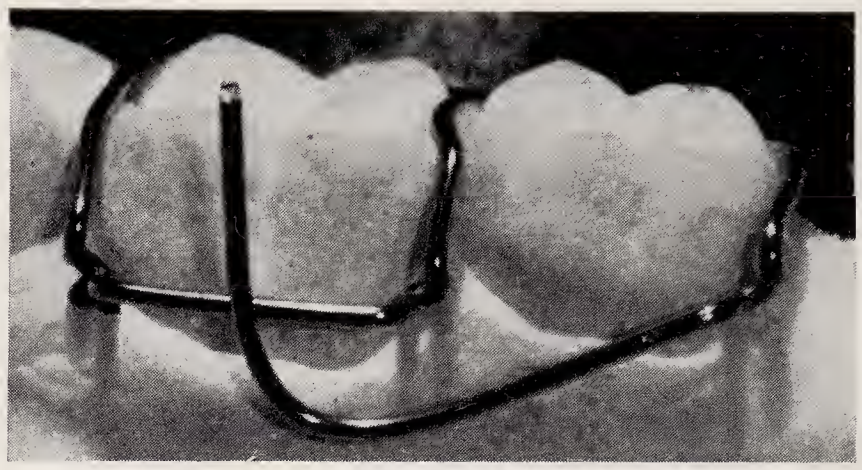
Fig. 8.—The welded or soldered hook. Can be put on if hooks have been overlooked in the construction of the plate.

Fig. 9.—The single arrowhead.

Tubes.—It is common practice to-day to use tubes on modified arrowhead clasps either on molars for free-sliding arches used in the

retraction of upper incisors with intermaxillary or extra-oral traction, or on premolars for the attachment of a night-time extra-oral appliance to an intermaxillary traction plate.

A



B

Fig. 10.—The accessory arrowhead during construction.

These tubes are easily attached by free-hand soldering after the plate has been processed.

Fig. 11.—The accessory arrowhead in the mouth.

If the plate is replaced on the model on which it was waxed up and processed and a long length of tubing is used, orientation of the tubing is greatly facilitated. The actual length of tubing required is then cut free and trimmed down to size and smoothed (*Figs.* 12, 13). The base-plate material should be kept cool by covering it with a wet napkin during soldering. The tube may be attached to the bridge of the clasp laterally or directly above or below. If attached directly above or below, the tube is liable to interfere with the gum margin or with the occlusion as the case may be. If attached laterally, it may project too far into the cheek and cause irritation. The needs of each case must be carefully studied and the placing of the tube decided on with these difficulties in mind.

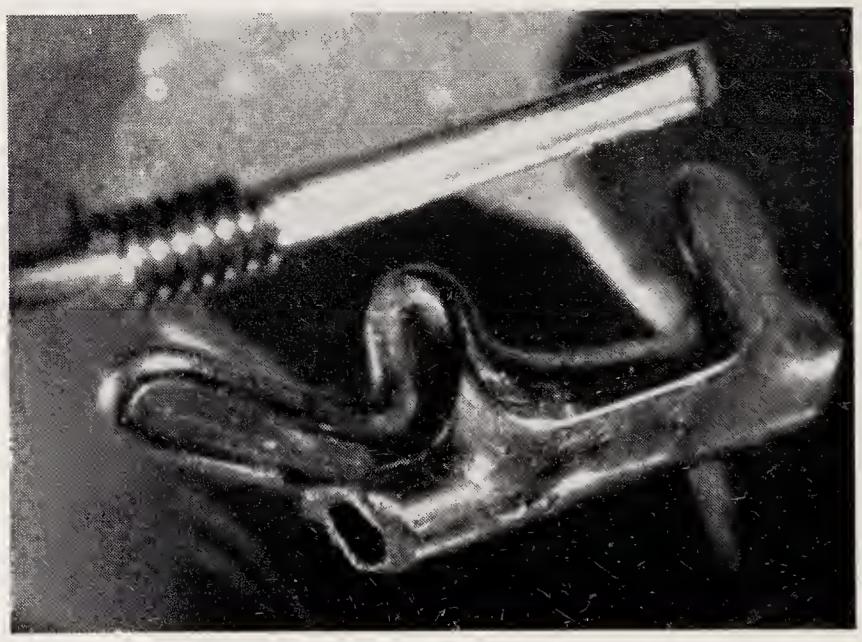


Fig. 12.—Tube on an upper first premolar showing the end of the extra-oral attachment which plugs into the tube.

Variation in Gauge of Wire.—Some operators have found that in their hands the clasps work better if made in certain circumstances in gauges of wire thinner or thicker than 0·7 mm. The writer has found that 0·7-mm. wire satisfies all requirements for molars, premolars, and deciduous molars. 0·6-mm. wire has been found most suitable for canines.

Fractures of the Clasp.—There are two sharp bends in the clasp, both in the neighbourhood of the arrowhead. If these bends are

made once during construction of the clasp, as they should be, and are not bent and re-bent, they will not break in use. It does happen occasionally, however, that a clasp

Fig. 13.—Tube on molar clasp for free-sliding buccal arch.

will fracture at one or other of these bends owing to over-stressing of the wire during construction of the clasp. If the wire is cleaned with a cuttlefish disk and the ends accurately opposed with the wire made passive, the lumen of the loop may be filled with solder, so effecting a rapid repair (*Fig.* 14). The base-plate adjoining the clasp should be wrapped in a damp napkin for protection during soldering.

The author wishes to acknowledge the suggestion of the single arrowhead (*Fig.* 9) by Mr. F. D. Rowe, L.D.S., of Liverpool; and the loop hook (*Fig.* 7) by Miss C. C. Jefferson, L.D.S., of the Eastman Dental Hospital, London.

The author is greatly indebted to Mr. D. R. McDougall, of the Department of Photography, Eastman Dental Hospital, for his painstaking care in the preparation of the illustrations for this paper.

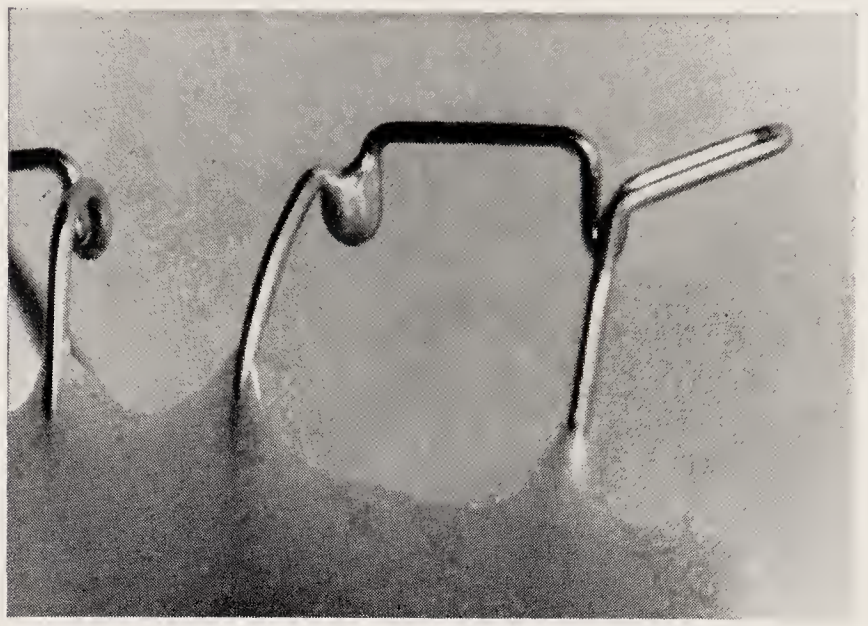


Fig. 14.—Soldered repair of arrowhead.

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ORTHODONTIC TEACHING MODELS

By **J. S. ROSE**, B.D.S., F.D.S. R.C.S.

ORTHODONTIC teaching models were demonstrated to illustrate movement of single teeth or groups of teeth by removable appliances. The models were constructed in acrylic simulating natural mouth colours. The bases of the models were hollow and the moving sections were attached to the main portion of the models by rods and tubes, along which the desired movement could be achieved by activating the appliances.

Fig. 1.—Buccal segment retracted, $\underline{|3}$ in position.

Fig. 2.—Model with appliance in position, before "treatment".

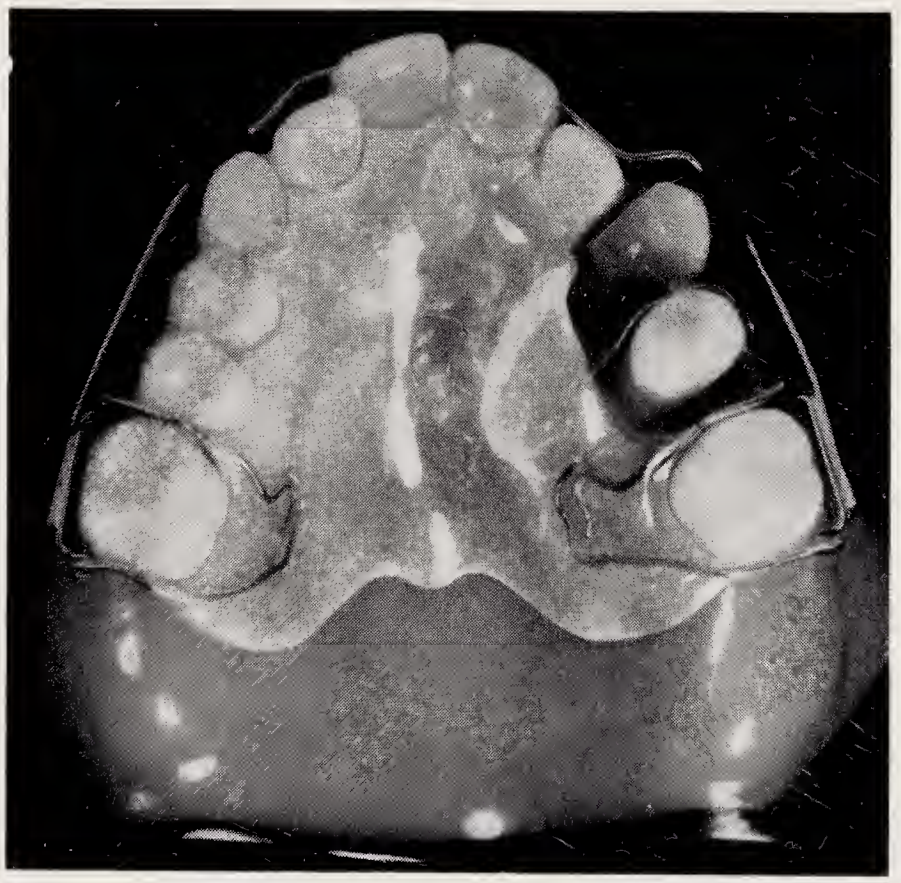

Fig. 3.—Case "treated".

The models presented showed:

1. *Treatment of an Outstanding Canine* by:—

a. Distal movement with a Schwarz plate of the buccal segment, which travelled on a square rod and tube as the screw was turned, thus accommodating the canine. *Fig.* 1 shows $\underline{|3}$ in place with the buccal segment retracted. Guide rod is shown.

b. Extraction of the second premolar and distal movement of the first premolar along a tube to accommodate the canine. *Fig.* 2 shows appliance in position before $\underline{|5}$ was extracted. *Fig.* 3 shows $\underline{|5}$ extracted, $\underline{|4}$ retracted, and $\underline{|3}$ almost in place.

2. *Treatment of a Superior Protrusion* by extraction of first premolars, retraction of the canines along tubes, and subsequent retraction of the incisors, which were individually suspended to allow them to be retracted.

A demonstration at the meeting held on May 10, 1954.

A PORTABLE CRANIOSTAT FOR USE WITH NORMAL DENTAL SURGERY EQUIPMENT

By **G. C. DICKSON**, B.Ch.D., F.D.S. R.C.S.

THIS craniostat was designed for use in dental surgeries in widely separated hospitals and had to be carried by car. It is based on an original design for a multi-purpose head orienter by Freeman (1950) and Rasmussen (1950).

It consists of a square-section rod which carries at one end a cassette holder and fixed ear-post. The other ear-post is carried on an accurately sliding arm, and between the two is an adjustable neck-rest. At the opposite end is a device for attaching the X-ray tube and a 45° mirror, which is used to observe the tilt of the patient's head (which is otherwise not possible because of the bulk of the X-ray head). The whole is supported on a rod which can be inserted into the dental chair in place of the head-rest.

Fig. 1.—Craniostat attached to dental chair.

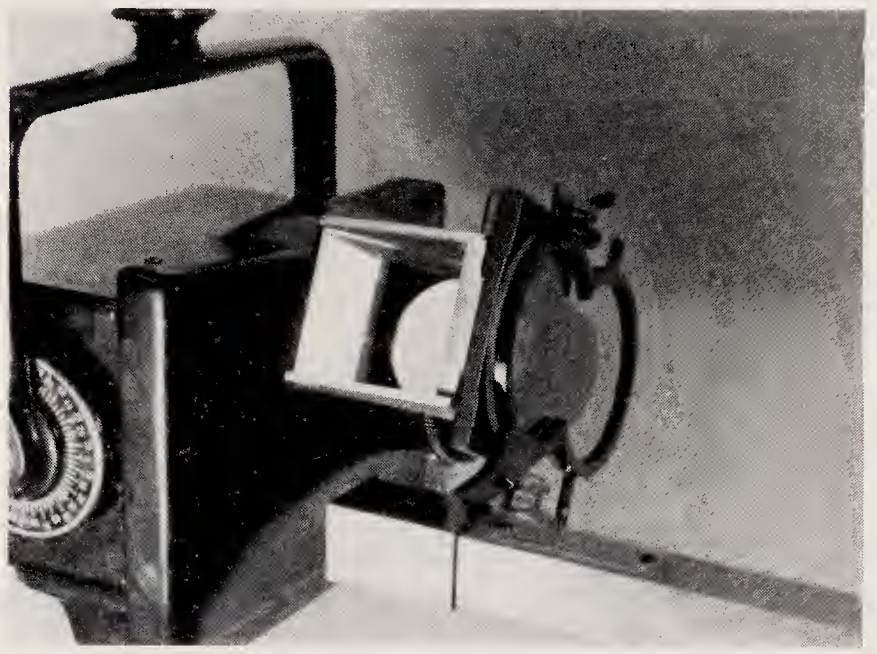

Fig. 2.—X-ray tube end of craniostat showing mirror for observation of patient's posture.

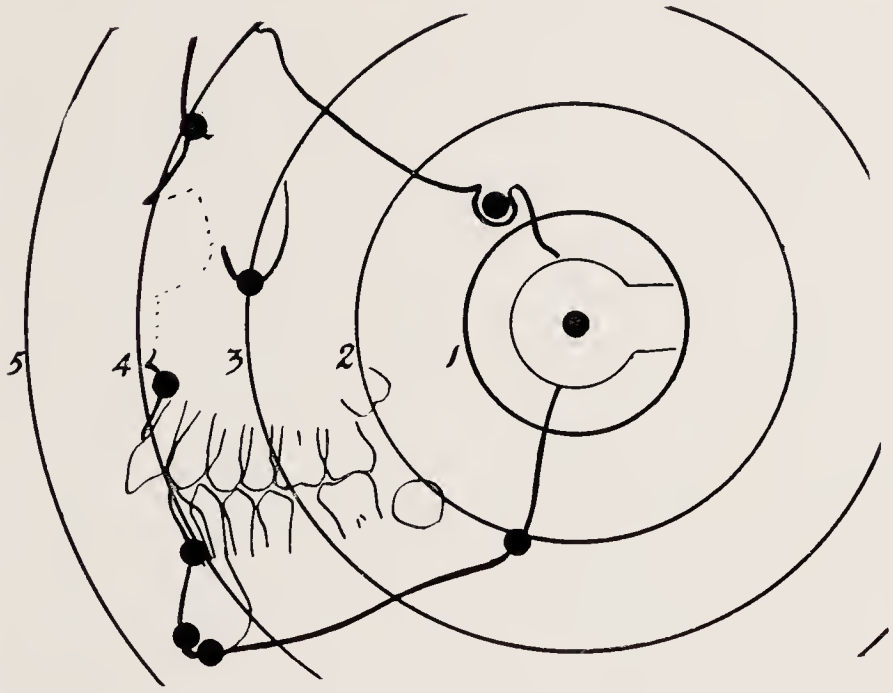

Fig. 3.—Diagram showing relation of points used in analysis to central ray; A, opposite porion; B, opposite "molar position."

A demonstration at the meeting held on May 10, 1954.

In use the central ray passes through the molar region. This point is chosen because it lies roughly in the centre of the points used in clinical cephalometrics and thereby tends to reduce the distortion caused by the short anode-film distance (3 ft. 6 in.). An arbitrary position measured 1 in. below the Frankfurt plane from a point 2 in. from the porion is used.

If desired the sighting can be removed and the X-ray tube attached in the more usual position, with the central ray passing through the two external auditory meati.

A comparison of films taken in the two positions shows no difference which could not be attributable to observational error (e.g., 0·5° in angle SNA) while the clarity of the pictures, particularly in the dental region, was definitely greater in films taken from the "molar position".

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APPLIANCES USED IN THE ORTHODONTIC TREATMENT OF CLEFT-PALATE CASES

By **D. P. WALTHER**, D.S.R.C.S., M.R.C.S., L.R.C.P.

THE aim of this demonstration was to show various types of appliances used in the orthodontic treatment of cleft-palate cases.

Fig. 1.—Pre-operative splint.

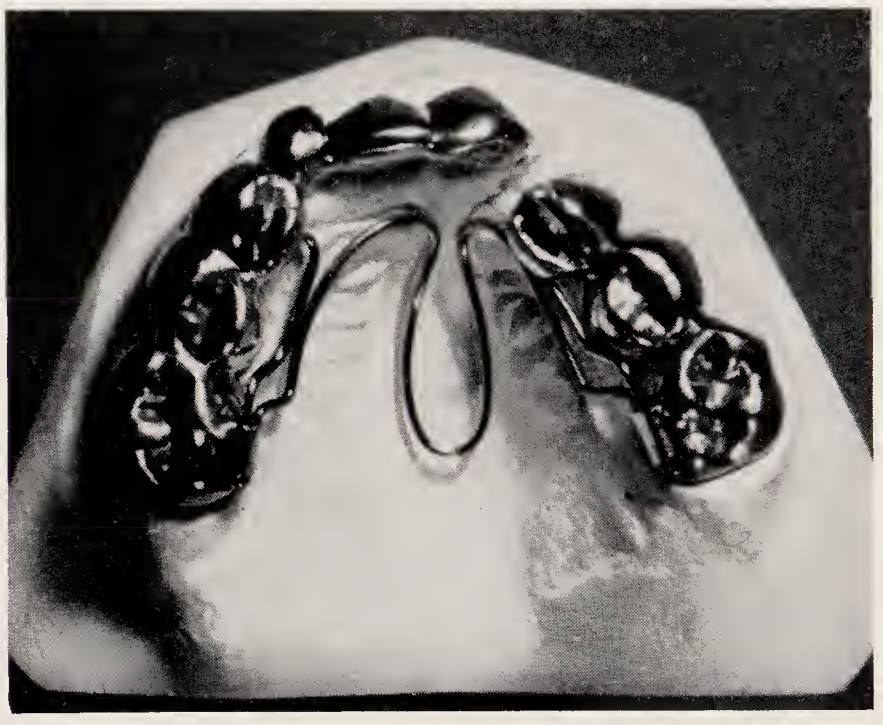

Fig. 2.— Pre-operative splint divided with palatal element.

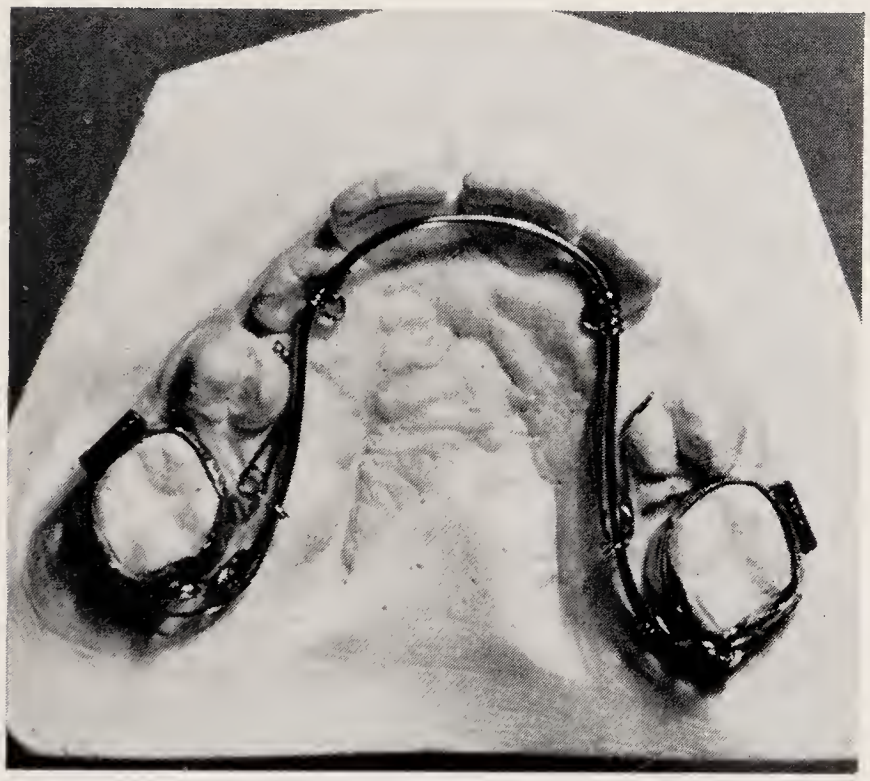

Fig. 3.

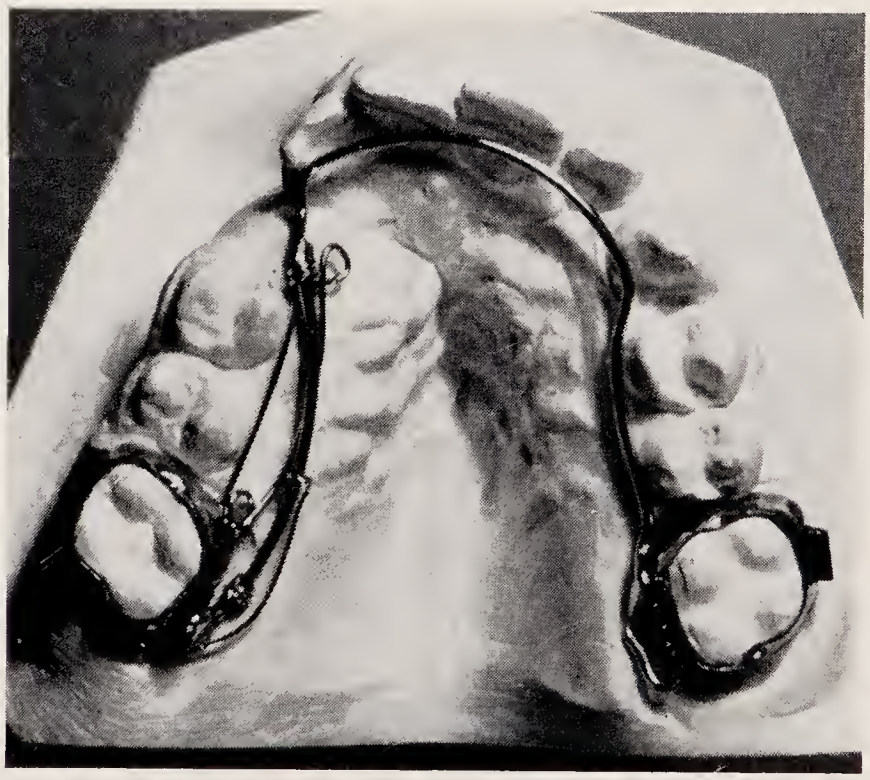

Fig. 4.

Figs. 3, 4.—Fixed appliances with molar rotation springs and auxiliary springs.

A *pre-operation splint* is shown in *Fig.* 1. The lip is closed at the usual early age, but the operation for closure of the cleft of the palate is delayed until the patient is about $2\frac{1}{2}$ to 3 years old. The splint is cemented in just before operation and is left in place for six months. If it is necessary to correct an arch deformity then the splint is divided as shown in *Fig.* 2 and the palatal element fitted.

A demonstration at the meeting held on May 10, 1954.

Fig. 5.

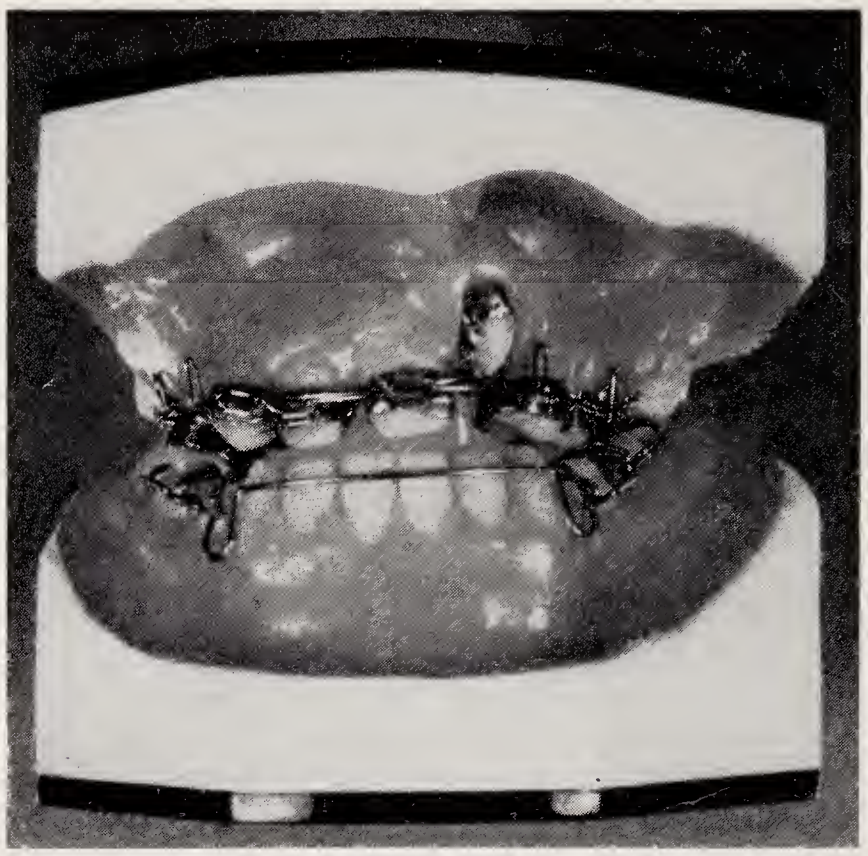

Fig. 6.

Figs. 5–7.—Multiband appliances.

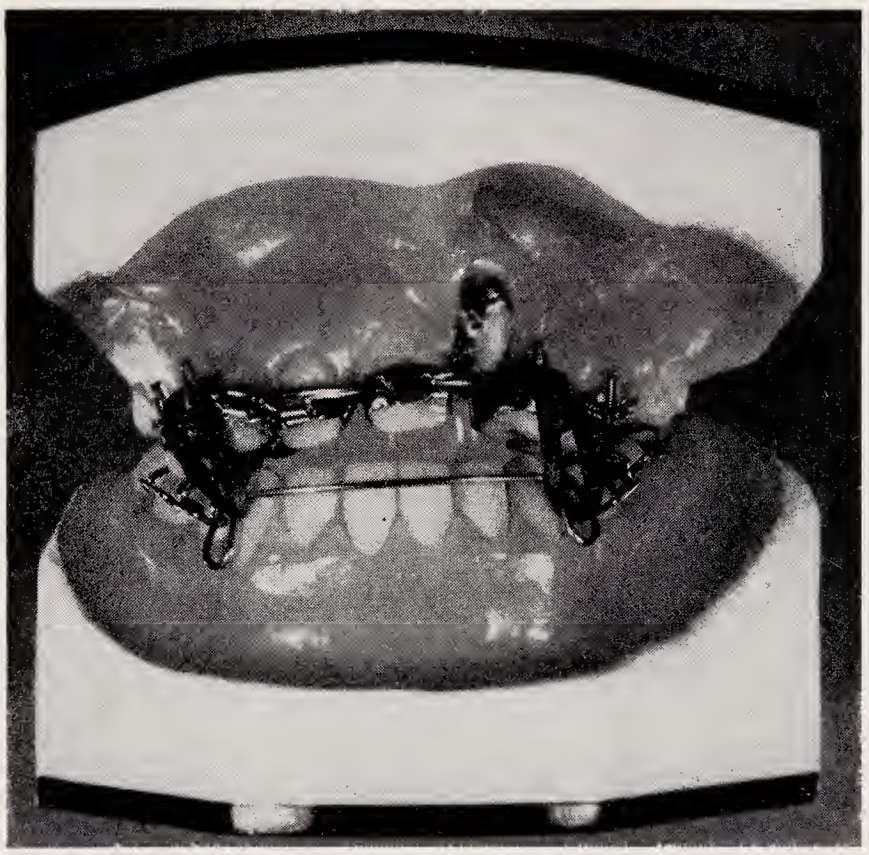

Fig. 7.

Fig. 8.

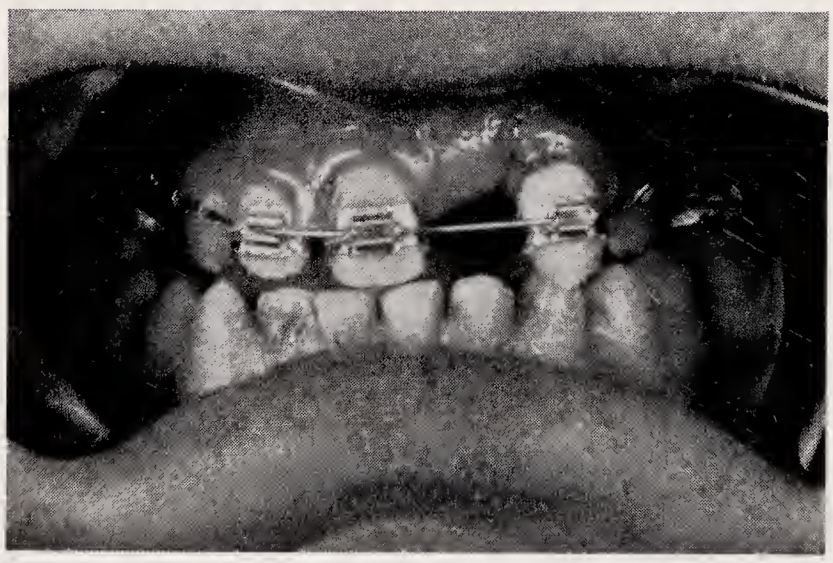

Fig. 9.

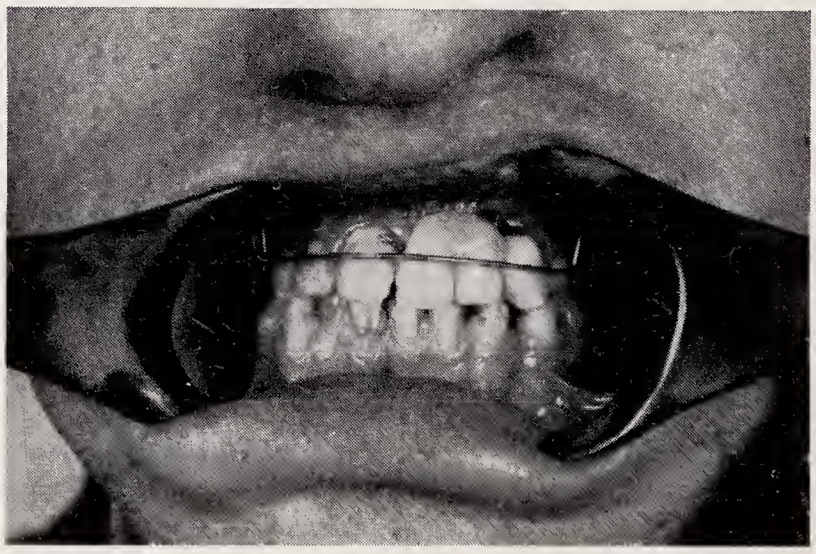

Fig. 10.

Figs. 8–10.—Closure of anterior open bite using multiband appliance technique.

When this has been done the arch is retained with an upper removable appliance. It was explained that, apart from this, no treatment was usually necessary until the eruption of the permanent incisors.

An appliance called a McNeil's stimulator was shown; this is being given a trial in cases about this age at The Hospital for Sick Children, Great Ormond Street. It is claimed that it will close perforations left in the palate not only with soft tissue but with deposition of bone. Up to date we have had no positive results. It is usual for the perforations to become smaller by proliferation of soft tissue, especially if covered by a simple acrylic plate.

Removable appliances were then shown with palatal springs to correct the lingual occlusion of the upper incisors. Some of these incorporated several methods of upper expansion. It was pointed out that it was generally preferred to delay the upper expansion and swinging out of the buccal segment until the premolars had erupted.

Fixed appliances were then shown (*Figs.* 3, 4), with rotation springs from a palatal arch to rotate the molars if necessary and auxiliary palatal springs when required.

The advantages of using an upper multiband appliance (*Figs.* 5–7) with a 0·022 in. (0·55 mm.) buccal arch with third power bends and loops was explained, incorporating a fine 0·014 in. (0·35 mm.) auxiliary arch if very gentle pressure was required. It was pointed out that this type of appliance was especially useful in treating the anterior open bite which is so common in these cases. A removable lower or fixed appliance can be used with anterior intermaxillary elastic for this.

Large serial photographs of patients before, during, and after treatment were also shown. These demonstrated the successful closure of this anterior open bite (*Figs.* 8–10).

TOMOGRAPHY IN CLEFT PALATE

By **FRANK L. INGRAM,** D.M.R.D., L.D.S., M.R.C.S., L.R.C.P.
Consultant Radiologist, Eastman Dental Hospital

When the maxilla is deformed by a cleft, it is difficult to demonstrate the deformity by ordinary radiography. The deficiency in the bone can be shown by tomography in vertical para-coronal planes.

The apparatus is arranged as in *Fig.* 1, with a linking bar connecting the downwards moving X-ray tube with the upwards moving film carrier. This bar rotates during the exposure about a fulcrum point, the position of which can be altered. The head is located by craniostat ear-plugs and the fulcrum point is set at a certain distance in front of these. All objects in the vertical plane through the fulcrum cast sharp shadows on the film, but objects behind and in front of this plane have their shadows blurred by the relative movement of the tube and film about the fulcrum during the exposure.

Films are made with the fulcrum at from $1\frac{3}{4}$ to 3 in. in front of the ear-plugs in $\frac{1}{4}$-in. or $\frac{1}{2}$-in. steps.

The illustrations show films of a normal maxilla at 3 in. (*Fig.* 2); a bilateral cleft at $2\frac{1}{2}$ in. (*Fig.* 3), and a right-sided cleft at $1\frac{3}{4}$ in. and $2\frac{3}{4}$ in. (*Figs.* 4, 5). The bony floor of the nasal fossa is a thick layer in the normal but a thinned and partially absent layer in the abnormal. The width of the cleft at various parts of the mouth can be judged, and it is hoped that any response to treatment may be observed by repeating the tomography at 6-monthly and 12-monthly intervals. The position of the chosen plane in each film is indicated by the tooth shadows which appear most sharp.

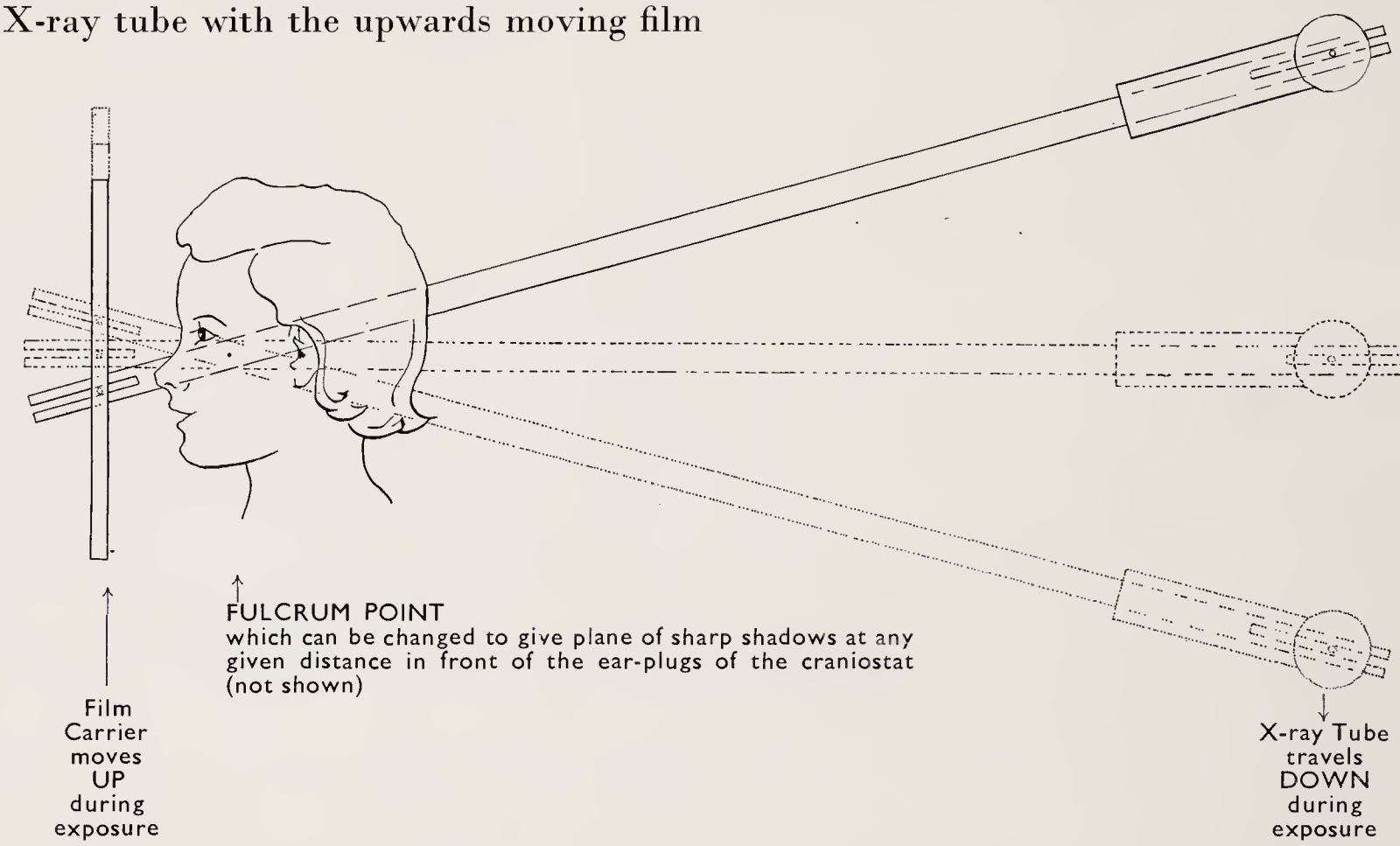

Fig. 1.—Simplified diagram of technique for tomographic investigation in cleft palate.

A demonstration at the meeting held on May 10, 1954.

Fig. 2.—Tomograph made through the plane 3 in. anterior to the ear-plugs in a normal maxilla. The incisors are in this plane.

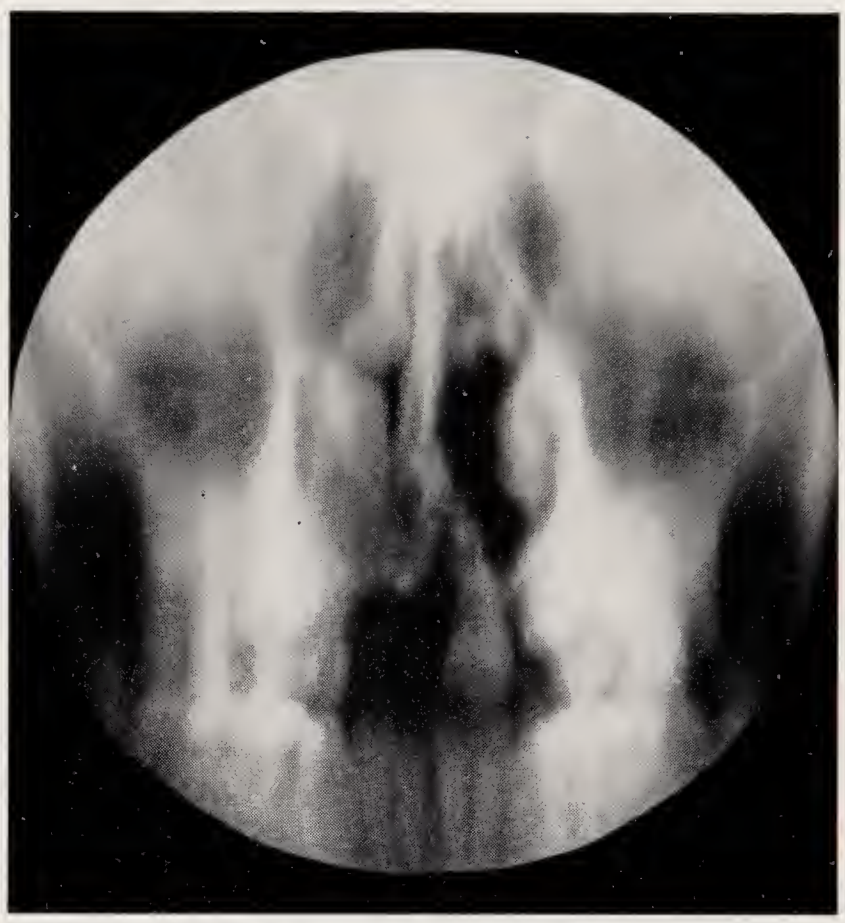

Fig. 3.—Half an inch farther back in a maxilla with a bilateral cleft. Lower incisors are blurred, upper incisor is sharp.

Fig. 4.—Three-quarters of an inch farther back still in a patient with a cleft on the right side. The second molars cast sharp shadows in this plane.

Fig. 5.—The same maxilla in the plane of the incisors.

MANDIBULAR DISPLACEMENT

By **JOHN CAMPBELL**, Ph.D., D.D.O. L.D.S.

I WISH to preface my remarks with a few words of explanation. I have been interested in facial neuralgia for many years, particularly that obscure type which originates in the temporomandibular joint. My first attempts at "bite-rehabilitation" were made in the pre-war period, and it was fortunate that they were successful; those initial cures inspired me to continue.

Seven years ago I let it be known among my hospital friends that I was willing to accept as a patient any adult who suffered facial pain which could not be diagnosed. My object was to test the efficacy of mechanotherapy.

A research team was formed from Dr. Gaylor, neurologist, Dr. D. Riddell Campbell, physician, Mr. Hamish Anderson, Dr. Tom White, and my other orthodontic colleagues, and myself. In the early days we had some valued discussions with Mr. Arnold Nove. The patients were not numerous at first, but the numbers "snow-balled" as the service became known.

We decided that during the first four years no concurrent therapy would be given, so as to avoid confusion of results. Therefore, during that period, no drug, injection, heat treatment, or physiotherapy was administered, although to-day we will employ any method thought beneficial. We even took care not to enthuse on the prospect of cure in front of the patient, so as to be able to refute any charge of "faith-healing".

The experience gained in treating over 500 patients has proved beyond any shadow of doubt that the temporomandibular joint can be the seat of pain, sometimes so severe that it can simulate tic douloureux. Furthermore, a fair proportion of patients who suffer obscure facial neuralgia can be cured by re-positioning their condyles, using intra-oral methods.

The research has passed into its second phase and we now investigate the contributory causes, and the reason why some cases are successful while others fail. Moreover, we now realize that temporomandibular joint disorders can be separated into several distinct clinical entities. The salient point which has emerged is that facial neuralgia is commonly multi-factorial; that is to say, causative factors must be added together before the threshold of pain is crossed; it would be wrong to conclude that dysfunction of the joint is the sole cause. Therefore, to confine treatment to "bite-rehabilitation" is to invite failure, or at least to provide such a restricted service as to bring this new therapy into disrepute. Facial pain has systemic and psychological connotations, and strain upon the temporomandibular joint should be regarded as no more than the "last straw that broke the camel's back".

The diagnosis and treatment of facial pain is such a vast subject that I am convinced that it cannot be handled by any single practitioner, unless he can readily consult medical specialists in the appropriate fields.

Facial pain is such a complicated subject that it is difficult to find a theme that can be intelligibly discussed in a single lecture, and in one hour I cannot hope to convey the story of our work and explain the theories upon which treatment is founded. As Hovell said recently in another context, "It is quite impossible, of course, to separate aetiological factors into completely water-tight compartments and to discuss any without reference to others". My paper will be limited, therefore, to a few basic points of diagnostic importance.

SURVEY

At an early stage we realized that if we aimed to re-position the condyles we would need accurate data. Roentgenography appeared to be the best medium for ascertaining the position of the condyles. We examined every available radiographic technique: those which presented the temporomandibular joints in oblique projection were eliminated, laminagraphy finally being standardized. I do not rate laminagraphy highly for exposing bone

Being a paper given at the meeting held on October 11, 1954.

rarefactions, or indeed for any critical examination of bone itself, but it has no peer for demonstrating the functional movements of the condyles.

Other methods of condylar survey were explored and some will be mentioned later. However, I must emphasize that pain cannot be diagnosed from measurements alone; many persons show gross malfunction yet do not suffer. On the other hand, pain has followed a trivial "raising of the bite" by a gold inlay. I do not underestimate the value of the accurate measurement of condylar displacement, but that is a matter rather for the research worker than for the clinician; the latter can get along perfectly well with a good pair of eyes and palpating finger-tips, provided that all have been educated to appreciate relevant detail. However, there is a duty imposed on the research worker to record pertinent data in specific dimensions, so that he can make a proper appraisal of his work, and so that he can impart his findings to others.

While we are discussing the measurement of the extent of condylar displacement, it might be wise to sound a word of warning on subjecting the temporomandibular joints to overzealous correction. At first glance one is attracted to the idea of measuring the amount of condylar displacement, and then making an appliance incorporating the exact dimensional correction. I am not obsessed with the fetish of "plu-perfect" correction; a full correction in one stage may be harmful: it is better to reposition the condyles in gradual stages rather that to overdo it. Each stage of correction should be within the toleration of the patient.

THE BREAKDOWN OF OCCLUSION

The orthodontist labours to produce the greatest functional efficiency consistent with æsthetic harmony in the masticating face of each child entrusted to his care. To befit himself for this task, he, the orthodontist, has spared no effort to learn all he can of his subject, and his researches have covered much ground, but I submit that his interest in the growth of the dentition has blinded him to the significance of its breakdown. This is regrettable because there are many lessons to be learned from the breakdown of occlusion which the orthodontist is pre-eminently qualified to comprehend. He will appreciate many points directly pertaining to orthodontics from the study of his own patients grown to middle-age, but he will learn even more from the occlusal breakdown of patients who have never known orthodontic care.

In presenting this paper, I have a threefold purpose. Firstly, I wish to demonstrate that irregular occlusal contact can displace the mandible and its condyles; secondly, I shall discuss with you the effect of displacement on the muscles and on the ligaments; thirdly, I wish to proclaim the serious consequences of condylar displacement, because it is not yet sufficiently recognized that a certain type of person, cursed with a low threshold to pain, will be precipitated into facial neuralgia by condylar displacement.

DISPLACEMENT: DEFINITION

Now, the discussion of displacement must begin with the inevitable question, "Displacement from what?" So we start on a search for criteria with which to evaluate mandibular and condylar displacement. As far as the mandible is concerned, the clinician gauges the manner of displacement by observing the shift of the lower incisors relative to the uppers. However, in our clinic we derive greatest help from a set of laminagrams showing the condyles in selected stations on their pathways of movement.

Dealing with the translation of the human condyle, the first point I wish to make is that the standard anatomy text-books leave the impression that all temporomandibular joints work alike. This is not so: from individual to individual, structure and function show great diversity; we are not stamped out of a common mould. Nevertheless, the diagnostician would be in a position of advantage if he had a mental vision against which to match the patient, but the image must be an idealized version of the patient himself, and not a norm common to all humanity.

Now while I cannot believe that every temporomandibular joint operates in the

self-same fashion, there comes a point which demarcates correct function from incorrect. In other words, a certain amount of unconformity is admissible, but, beyond this stage, the function is truly abnormal. In the subsequent discussion I shall use the term "normal" in the sense which has just been explained.

Dynamic Occlusion.—Until recently the orthodontist had little interest in the moving mandible. To the orthodontist of the last generation, the term "occlusion" conveyed the idea of that static maxillo-mandibular relationship which was used by Angle as a point of departure for case-analysis: the patient was asked to clamp his teeth together as a preliminary to his orthodontic classification; little thought was given to the possibility of mandibular displacement by cusp interference. A cusp interference can push the jaw awry, and we now know that it can deceive us as to orthodontic classification.

In cusp interference, an upstanding tooth knocks against an antagonist; next comes a slide of the lower tooth over its opponent, this being a movement which strains the pericemental membranes and tends to displace the condyles. The closure of the jaw stops when the teeth engage in what has been called "centric". If the teeth meet in deflected relationship, then centric is "false"; if the teeth interdigitate at a proper occlusal level without strain, then centric is "true".

False Centric is not easy to Recognize.—By causing occlusal derangement, the extraction of teeth paves the way for mandibular and condylar displacement. To illustrate this point we envisage a patient who hitherto has had a good occlusion, but who has just lost teeth that had maintained the vertical dimension. The mandible now closes more than formerly, and for the first time inclined dental surfaces meet; unfortunately they meet in such a fashion that the jaw is jerked off its true pathway.

The deflection of the jaw is readily detected immediately after the extraction, perhaps even for some time thereafter, but sooner or later the jerk disappears from the pathway of mandibular closure, because the nerve-endings in the tendons and in the pericemental membranes have learned how to close the teeth on a track which avoids impedimenta. Therefore, the deflection of the jaw is not so obvious in later years, and may only be recognized by the abnormal inclination of the pathway of closure.

Bone-growth may compensate with an Abnormal Pathway of Closure.—During the years of childhood, bone metabolism may adjust the shape of the parts to make amends for the mutilation. However, an adult cannot be expected to overcome the handicap of a newly acquired cusp interference as well as a child. The difference in response depends on whether the compensatory bone-growth is exhausted: an adult can no longer evoke the maximum osteoclastic and osteoblastic activity. Compared to the child, he is more likely to become the victim of a torn temporomandibular ligament, and a condyle displaced with every bite.

It would be unfair to leave you with the impression that these dire consequences follow every extraction of permanent teeth. On the contrary, it is easy to recall to memory persons with neglected temporomandibular joints who did not pay the penalty in pain. Bearing this in mind, an unbiased and balanced judgement must be cultivated by the practitioner who sets out to treat facial pain. It is paradoxical that an apparently good joint can be painful, while an apparently bad joint can be painless: clearly, the answer is to be found in the contributory causes and in the inherent native resistance.

RECORDING OF CONDYLAR MIGRATION

The study of condylar displacement is inseparable from the study of mandibular relations as a whole. Let us begin our discussion of mandibular relations with a brief analysis of the rest position of the jaw, or "rest relation" as I shall call it from now on. First, we shall examine the postulate that mandibular displacement starts from rest relation.

Many articles have been written on how to locate rest relation, but if the truth be known, no method is infallible. Of the more elaborate techniques, electromyography holds out the greatest promise, as anyone will testify who heard Tulley (1953) on this subject last session.

This revolutionary research tool may solve some of the aetiological problems of the orthodontist. However, most clinicians will continue to determine rest relation by clinical judgement, by phonetic methods, and by the more reliable mid-sagittal cephalometry.

Ingenious techniques have been evolved for making tracings of mandibular excursions: records can be made in any of the three planes of space. For tracing sagittal movement, a waxed plate is fixed anteroposteriorly to the upper jaw, and a stylus is carried on the moving mandible. The diagram inscribed in the wax registers the opening, closing, protrusive and retrusive excursions. The outermost limits of excursion are recorded as the so-called "border movements".

Johnston (1954) has used such an instrument for recording the click in a temporomandibular joint. It can also demonstrate an abnormal inclination in the closing path of the lower incisors. It can be used to locate the vertical component of rest relation, because the stylus will dwell on the part of the diagram where the jaw rests between movements.

Rest Relation and the Gothic Arch Tracing.— For a long time, the prosthetist has experimented, in edentulous patients, with the gothic arch technique for locating rest relation in its horizontal aspects. Compared to the prosthetist, the orthodontist encounters greater difficulty with the gothic arch technique because of the presence of teeth which lock the occlusion against excursion. Therefore, as a preliminary, all natural teeth must be covered with thin plastic overlays, ground flat into occlusal equilibrium in every excursion of the jaw. The overlays should open the vertical dimension to the minimal extent, otherwise the change of occlusal level will alter the position of centric. The overlays are placed in position and the patient is asked to move his jaw in every conceivable excursion, so that the stylus on one jaw scratches into the wax on the other. Now, if the patient has a constant rest relation, the return of his jaw to rest at the end of each movement will generate an arrow-head in the wax, and the apex of this figure ought to be sharp. However, some patients cannot scribe a sharp apex. I am satisfied that bluntness of the arrow-head denotes duality of centric; that is to say, in such cases the condyles have too much lateral play. In passing, it may be said that duality of occlusion is seen in children as well as in adults.

In cases where the polar ligaments of the capsule have been torn, the meniscus floats about independent of the movements of the condyle, that is, it no longer caps the condylar head in its translations. In that case, there is bound to be resiliency in the joint, and the condyle can be pushed into abnormal situations according to how it is manipulated. For this reason, it is my opinion that the registration of occlusion from data derived from gothic arch tracing is unpredictable; the bite-blocks may be higher at one side than the other so that if the condyle floats freely it may be pulled down.

Tracing techniques may be successfully employed in young persons with undamaged joints, but they have little value in old ladies who have worn the same complete dentures for forty years.

CUSP INTERFERENCE WITHOUT LOSS OF TEETH

We return to the subject of cusp interference by re-stating the usual sequence of events. First comes the extraction of the teeth, then cusp interference, which simultaneously displaces the mandible and the condyles. But we must not overlook the fact that cusp interference can occur in a mouth with every tooth present: in such a case dental irregularity taps the closing jaw into false centric (*Fig.* 1).

There is a type of Class II, division 2, which shows this feature. In this instance the lower incisors strike against retroclined uppers; so that when the patient exercises the human desire to chew with his posterior teeth, the incisal contact deflects the whole mandible backward into false centric. This does not signify that the condyles are deflected when they return to their resting relationship; indeed, they may have been out of position only when incising, and because the patient "grew up with her anomaly" she may have evoked bone metabolism to adapt her joints.

It is within the bounds of possibility that the condyles were gradually adjusted to lie in the best resting position at the end of the masticating stroke, despite the evident backward shift of the lower incisors.

Many Class II, division 2, patients have over-erupted incisors, or alternatively their posterior teeth are under-erupted. If the jaw of this type of patient is examined as it rests, it will often be found lying in front of the position it will assume when fully closed. Indeed, we have seen patients whom Angle would have classified as Class II approximate more to Class I when the jaw is relaxed.

I was privileged to inspect a case treated by Mr. Russell of our department. A Class II, division 2, 14-year-old girl had a noisy bilateral temporomandibular joint "click". In the course of routine orthodontic treatment which tipped forward the retroclined upper centrals, the click disappeared. Rest relation was examined before and after treatment, but we could find no alteration. However, it was evident that after the upper centrals had been moved forward out of the way of the lowers, the latter could swing home towards centric on the true upward and forward arc, whereas before treatment the lower incisors had been deflected on the retroclined upper centrals.

A B

Fig. 1.—Model of Class II, division 2. In A the jaw lies at rest. In B, the lower incisors have slid on the retroclined uppers, displacing the mandible and its condyles backward.

The "Postural Class III".—The so-called "postural Class III" offers another example of "setting the scene" for a prospective mandibular displacement. I have been consulted by a few patients of this order suffering from severe facial neuralgia, the onset of which coincided with the loss of their supporting posterior teeth. The lower incisors, which had hitherto rested slightly to the labial of the tips of the uppers, were now given the opportunity to close over the labial surfaces of the uppers. The forward and upward displacement of the lower incisors has its reflex in the rest relation of the condyles; the patient habitually assumes a "bull-dog" look.

Now, the interesting point is that some of those patients develop a searing neuralgia, of a quality which resembles tic doloureux, and in such an instance we must discount the well-known theory of Costen who claimed that the pain was caused by the condyle pressing on the auriculotemporal nerve: in this type of case the condyle is displaced forward.

False Centric useless as a Standard Maxillo-mandibular Relationship.—From the examples quoted, it will be seen that centric is so liable to be false that it cannot be regarded as a completely reliable maxillo-mandibular relationship. If only we had a reliable relationship we would use it as a starting-point for the study of mandibular displacement.

Personally, while interested in mandibular displacement, I am more interested in condylar displacement: I merely use one as a "stepping-stone" to the other. For determining the extent and direction of condylar displacement, I am satisfied that the laminagram supplies the best possible information. In addition, the laminagram can be used to check if the condyle has been successfully replaced.

However, we must face the fact that the apparatus is not available to all who wish to study condylar displacement. In that case, the clinician will utilize the rest relation, which provides a fairly accurate "point of departure" for observing the displacement: we watch how the closing jaw shifts from rest relation.

But, the question arises, is rest relation itself reliable? I am afraid that we must admit that occasionally it can be called to question. Presently we shall discuss how it may change. However, if rest relation changes, it does so in a very gradual manner, and the change

cannot be compared to the sudden deflection of the jaw as a tooth strikes a cusp interference.

THE THEORY OF REST RELATION

Rest relation was first mentioned in dental literature in 1908 by Bennett: more recently it was studied in greater detail by Niswonger (1938), by J. R. Thompson (1946), and by many others. Most of these authors contend that the jaw rests in a predetermined position, and that rest relation is immutable throughout adult life. They believe that the posture of the jaw is maintained by the counter-balance between the flexor and extensor muscle groups, analogous to the balance achieved by two evenly matched "tug-of-war" teams.

My own opinion is that while it is true up to a point, the theory has been over-stated; surely reflex muscle activity is the main factor in stabilizing the rest relation, and a few words will be said later on this subject. But I cannot accept Thompson's theory wholeheartedly because of the amount of evidence to the contrary. For example, one has only to walk observantly along a busy street to see countless examples of the so-called "letter-box" mouth, every case implying that the chin rests closer to the nose than formerly.

However, a search through the literature suggests that there is a mellowing of opinion as to the constancy of rest relation; non-committal phrases are now taking the place of the earlier dogmatism, and the argument is pitched no higher than "rest relation has a high degree of stability after extractions"; variables of rest position are now frankly discussed. The pendulum of opinion is steadying up after having swung too far.

Now with all my criticism of the theory of constancy of rest relation, I consider it of extreme value as a good "rule-of-thumb" for teaching students how to set up dentures: after all, we cannot impart all our philosophic doubts to the young mind.

SHORTENING OF THE MASTICATING MUSCLES

I strike a controversial note when I suggest that the prolonged wearing of a full denture with excessive free-way space will tend to close the vertical dimension. There is a clear implication here that the closing muscles of the jaw have adopted a shorter resting length, and dental literature is full of references to the contrary. While dental authorities seem to be agreed that muscle length is unalterable in adult years, orthopædists and others outwith the dental field have no hesitation in declaring that muscle length can shorten. We picture a patient with a short leg: his orthopædic surgeon proposes to shorten the normal leg to equate it to its mate. Several surgeons have assured me that in such a case, each would be disappointed if the muscles failed to adapt themselves to the shortened bone. Furthermore, operations to elongate a leg are not unknown, and in this case also it is expected that the muscles take up a longer resting length.

Muscle Tone and Rest Relation.—As previously said, I am doubtful about those theories which explain the slung position of the jaw by an exact counterbalance of muscles. If the flexor muscles are powerful and bulky, and the extensors slim and relatively weak, then the strong would overcome the weak and close up the edentulous jaw. But as was said before, there is reasonable stability of rest relation, even in the edentulous mouth. Therefore the simple counterbalance of elastic muscle must be reinforced. As I see it, the reinforcement is furnished by the reflex mechanism, that is to say, the muscles, individually and collectively, are reluctant to change their resting length: while muscles *can* be educated to adopt a new length, they try hard to keep the length that Nature gave them; the mandible can only be persuaded out of its innate posture by continuous conditioning. The maintenance of resting length depends on the neuromuscular mechanism, known as the "tonic reflex".

It has been said that so long as there is life there is muscle tone. Tension varies from person to person, being greater in the athlete than in the asthenic type. The muscle tension is high when the individual is active, tense, or excited; it drops in fatigue. In the sleep of the elderly the droop of the jaw suggests that its weight, negligible during the waking hours, has become a material factor when the tension

falls; it further suggests that the elderly jaw can rest comfortably in more than one position, adopting a different rest relation according to the tension.

Variation in muscle tension is probably a significant feature in the aetiology of facial neuralgia; it is indubitable that highly-strung persons suffer pain to an inordinate degree.

Conversely, a good case could be made out that certain weak-muscled people are also prone to facial pain. Neuralgia has been found in a large number of slack-muscled, teen-age girls, who, it is interesting to note, can "click" several joints other than the temporomandibular. I wonder if the following hypothesis fits these cases.

Let us assume that this girl has generalized muscle weakness, and for the purposes of our theory, the low tonus is expressed in weakness of the external pterygoid muscles. Now, let us superimpose upon this weakness of external pterygoid, the loss of the supporting posterior teeth which had hitherto protected the joints from over-closure. When the patient now makes chewing movements, the condyles tend to slide up into the depths of the glenoid fossa, compressing the meniscus. If the external pterygoid muscles had been stronger, the condyles would have been held more securely against the sloping eminence. Thus the muscle weakness is indirectly responsible for the painful straining of the ligaments around the joint. I hold the opinion that the ligaments were not meant to take the strain of heavy mastication, and that the thrust of the chewing stroke should fall on the posterior slope of the eminence, in a forward and upward direction. The ligaments are perfectly adapted to fit into this scheme, but they are ill-suited if the condyle is forced in another direction. Returning to the hypothetical case of the girl, the capsular ligament and the temporomandibular ligament become strained because occlusal breakdown has eliminated the first line of defence to the joints, and, secondly, because the external pterygoid muscles were not strong enough to hold the condyles in their physiological stress-bearing positions.

It will be seen that the posterior slope of the articular eminence is the stress-bearing point, not the glenoid fossa. The thin mass of bone which intervenes between the depths of the glenoid fossa and the brain is added proof that this part was not intended to take strain.

CASE HISTORY: HYPERTENSION OF MASTICATING MUSCLE

In complete contrast to the slack-muscled type, numerous patients have been examined who were in obvious high muscle tension. It should be interpolated that muscle tension can be high although it is seldom evoked: I have known patients break stout dentures in their mouths on witnessing a street accident. Many case-histories disclose that the onset of neuralgia coincides with a sudden emotional clenching of the jaw, especially in cases where the occlusion is incompetent to take the shock.

That the subject of muscle tension is tied up with our work is brought out by the following case-history. It is true that the story is unusual and of an extreme case, but many other patients have been met who exhibited high muscle tension in minor key. Aged 59, the lady arrived in dreadful distress, with her edentulous gums clamped together so tightly that they could not be parted. Her face was red and puffy over the right temporomandibular joint, and there was œdema over the knees, ankles, and finger-joints. Her temperature was normal, but her E.S.R. rose 20 in the first hour and 41 in the second. My first opinion was that her case lay outwith my province, but after consultation with our physician I decided to make a pair of soft plastic splints to "cushion" the agony of her spasms.

At the first visit it was impossible to take impressions, and I suggested that we should let a week go past to relieve the trismus, but to my surprise she asserted that her spasms never lasted more than five hours. This proved to be true; when she returned next day both muscle tension and pain were temporarily alleviated, and splints were made. However, at the beginning they appeared to be useless; they could not be worn for long before they were crushed out of her mouth by the intensity of the muscle contraction.

Five months went past and she was no better; the case was reviewed. The only

alternative we could think of was condylectomy, and this seemed justified as the right condyle had eroded into a sharp stump. I consulted Mr. Barnes (1954) who agreed that the operation was indicated. However, a fortnight before the appointed day the pain and trismus ceased, and the condylectomy was held in abeyance. Since that day, nine months ago, she has had neither pain nor spasm.

Now it might be argued that the prospect of the operation "frightened the pain away", but I am bound to say that she was overjoyed when an operation was proposed.

BRUXISM

Bruxism is another example of hyperactivity of the flexor muscles of the jaw. The tension may be intense: a child, for example, may grind his teeth in his sleep with such vigour that the sound may be heard all over the room.

Whether the cause is to be found within the masticating face, or whether it is systemic, bruxism is essentially a neuromuscular phenomenon, and consequently can exist if the teeth are present or absent. The obnoxious habit of champing on a full denture is allied to bruxism, and is generally associated with a misfitting denture with excessive free-way space: that is to say, during the fraction of a second when the jaw is over-closed in chewing, the condyles are displaced backward. Indeed, this may direct attention to the site of the irritation which manifests itself in the form of restlessness of masticating muscles.

REFLEX MUSCLE ACTIVITY

Reflex muscle activity depends on afferent impulses coming from sense organs embedded in the muscles themselves, mostly in the tendons of the muscles. The neuromuscular mechanism which adjusts the tension to the work to be done is known as "the stretch reflex". The stretch reflex is set in motion, for example, when a downward pressure is applied passively to the chin. This attempt to shift the jaw away from its normal position is resisted and appropriate reflexes are evoked. By contracting certain muscles and "paying out" their antagonists, an effort is made to stabilize the jaw as it was. Thus there is a continual fight to overcome dislodging tendencies, a "pull devil, pull baker" arrangement.

As Wright (1952) says: "Finally, it must be emphasized that posture is the basis of movement: all movements start and end in a posture, they grow out of a posture and return to it."

NEED FOR CAUTION DURING INTERMAXILLARY CORRECTION

On a previous page I tried to show that a condyle may function atypically, yet the action may suit the patient perfectly. It would be imprudent, therefore, to attempt an "improvement" which in actual fact would be no improvement at all. It would be rash to try to "correct" an occlusion just because it does not look right, because, maybe in his childhood, bone metabolism adjusted the patient's temporomandibular joints to compromise with his poor occlusion. I may say in passing, that once I had occasion to stay the hand of a young enthusiast who proposed to crown the natural lower posterior teeth of a pain-free adult, for no reason except that they had not erupted as far as the incisors.

Personally I would never interfere with any adult temporomandibular joint unless the patient suffered pain or disability. He would be a presumptuous man who would toy with such a delicate mechanism.

It is interesting to note that cases have been reported of orthodontists commencing mandibular retraction in young adults, hoping to improve the maxillo-mandibular relationship, but having to abandon the treatment on account of the neuralgia that developed. The orthodontist should consider well before embarking on intermaxillary traction at an age when bone-growth has slowed down.

However, in the case of children, a less cautious attitude is indicated, although the pace of the intermaxillary correction should be unhurried at all times. The corrective force should stop short of displacing the condyle backward, or alternatively, from pulling it forward right out of the glenoid fossa.

INTERPRETATION OF THE LAMINAGRAM

The set of laminagrams should depict the condylar position when the jaw has opened to its practical maximum, thus we could see if the condyle has translated too far or too little. The question arises, where should the condyle lie at the end of its opening excursion?

Fig. 2.—This laminagram shows the condyle lying in front of the crest of the articular eminence; this does not depict dislocation.

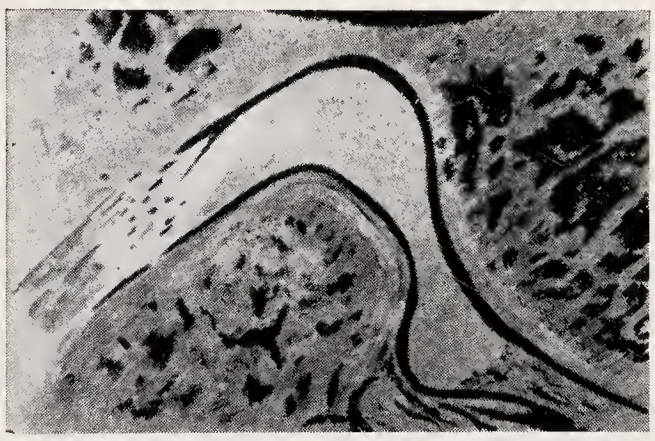

Fig. 3.—A comparison between the laminagram and the section of the temporomandibular joint.

Taking into consideration all the provisos that clutter up our concept of normality, together with other reasons too involved for present discussion, I ask you to accept that the condyles should reach the articular crests as the patient places his largest bite of food into his mouth.

When interpreting a laminagram, this is the first point to look for; in fact, it should be regarded as the beginning of a specification of correct condylar function: let us see if we can build it up into a complete specification.

Sometimes it is necessary to teach how an act can be wrongly done before its proper performance is appreciated. *Fig.* 2 is shown with this intention: the condyle may be recognized lying well in front of the crest of the articular eminence; further muscle traction has lifted it to a higher level. This state of affairs is common; we have scores of laminagrams showing this feature, some from the records of neuralgic patients and some from the pain-free class.

Fig. 2 does not illustrate a case of dislocation; in general these patients are unaware of their bizarre mandibular action.

However, while the condition is common, that does not signify that it should be ignored: in our clinic we continue to investigate its significance.

Interpreting the Laminagram showing the Condyle in Closed Position.—We now switch our attention to the laminagram representing the condyle in its retracted position. Ideally the laminagram should "cut" the condylar head midway to its long diameter. It would be perfect if the diagnostician had access to a dissection showing the part cut at that level. *Fig.* 3 shows a histological section of a temporomandibular joint in what must have been an

undamaged state. Let us interpret the laminagram with this picture in our mental vision.

It will be seen that the condyle does not fit exactly into the glenoid fossa, that the thick posterior rim of the meniscus lies up in the depths of the fossa, so that there is greater joint-space vertically above the condylar head than at that part where the condyle abuts the midway point of the posterior slope of the eminence; here the meniscus is thinnest.

We look now at the dimensions of the joint-space behind the condyle, that is to say, between the posterior aspect of the condyle and the tympanic plate. My opinion is that it would be sufficient if it equalled the anterior joint-space, but it would be better still if it were wider; it is obviously detrimental to have one's condyle approach one's tympanic plate.

DEFINITION OF PATHWAY OF NORMAL CONDYLAR TRANSLATION

So far we have defined the two end-points of condylar translation, but the specification must include the traverse of the condyle from one point to the other. It should be noted that we are not discussing the inclination of the pathway, because surely that depends on the slope of the eminence, whether it is upright or flat, a point which can be readily ascertained from the laminagram. Our present desideratum is the proximity of the *moving* condyle to the eminence.

It is inconceivable that the condyle should drift away from the eminence during its passage. If the joint-space alters its proportions when translating, then there must be looseness in the joint ligaments, and this is incongruous with the unstretchable nature of ligamentous tissue. I am, for the moment, accepting the assertion of the standard textbooks of anatomy in respect of the stretchability of ligament.

This opens up a new line of thought: how can the condyles translate so smoothly if the ligaments are unyielding? By way of explanation, I offer you this hypothesis, the essential point of which is that the condyles keep a close sliding fit to the surface of the eminence.

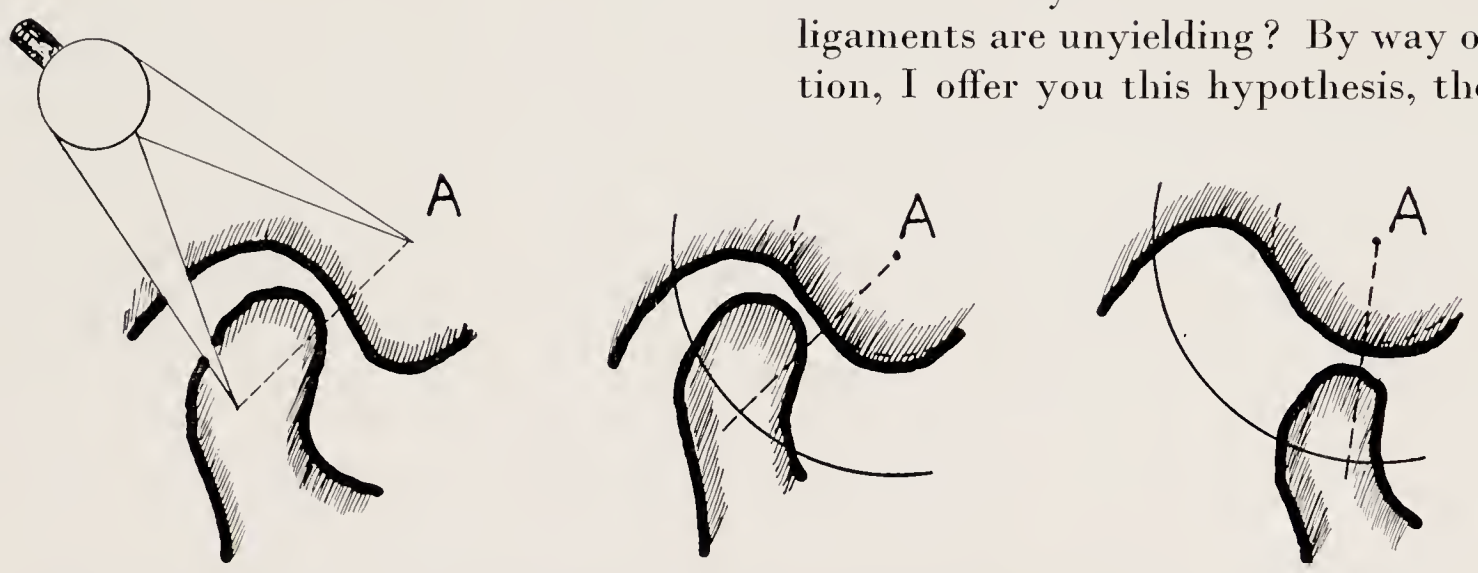

Fig. 4.—Diagram of the condyle in its rest relation and also at the nadir of its descent. Any individual ligament fibre swings in radial manner.

Fig. 4 demonstrates the condyle, first in its normal retracted position, and secondly after it has descended to the crest. It will be observed that the temporomandibular ligament fibres run up-and-down in the open position, and obliquely in the retracted position. As I see it, the fibres swing without elongation, and the condyle translates as if slung at the end of countless Lilliputian ropes, which not only prevent it from straying outwards, but keep it in firm sliding contact with the eminence.

Let us return to the interpretation of the laminagram and apply the lesson we have just learned. The argument now is that there ought to be uniformity of joint-space all along the pathway of condylar movement: laminagrams taken at any station in the course should exhibit the same joint-space. This is different from the joint-space of the static retracted condyle; there the joint-space should be wider vertically above the condylar head. In the case of the moving condyle, the theory applies to the thin zone where the condyle lies closest to the bone; it should remain identically thin throughout the translation.

We shall leave for the moment this theory of the swinging ligament fibres, returning to it shortly to see how it ties up with the well-established postulate on the wider opening of the jaw, as set forth by the American anatomist,

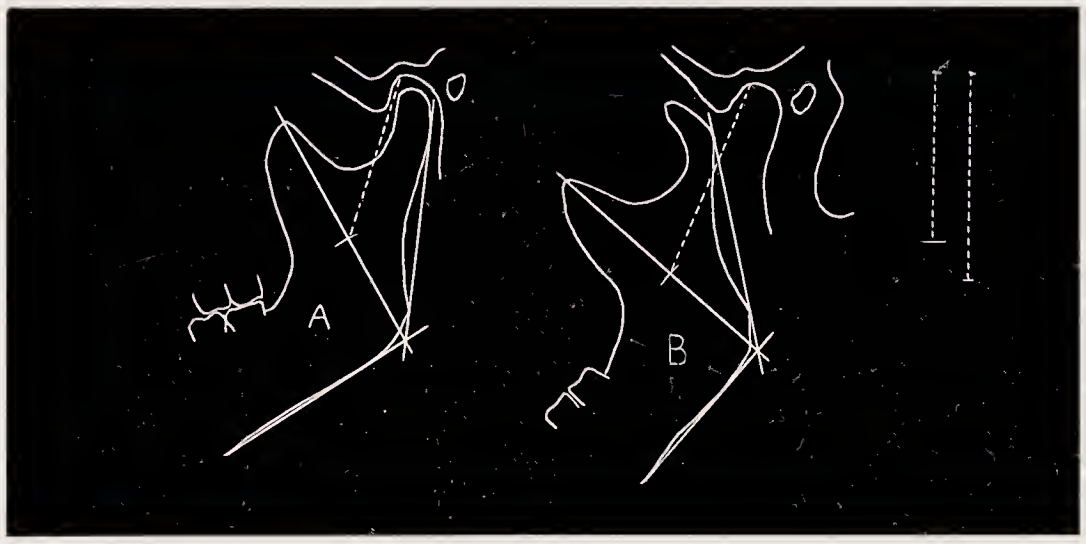

Fig. 5.—It has been claimed that the opening mandible pivots on a mid-ramus point. This tracing, made from actual laminagrams, suggests that a simple pivot will jam the condyle against the eminence.

Lord. He claimed that, in its wider ranges of opening, the jaw rotates on an axial pivot located at the insertion of the sphenomandibular ligament; that is to say, the chin drops backward, and the condyle descends as the jaw opens.

Now this is an attractive surmise, but Lord did not carry it far enough, because *Fig.* 5 strongly suggests that if the condyle swings radially around Lord's point, it will jam against the eminence. However, we need not take that too seriously; all difficulty disappears if Lord's centre itself shifts backward (*Fig.* 6).

I have made a piece of link-motion (*Fig.* 7) to show the interplay of three swinging movements: (1) the swing of the fibres of the joint ligaments which carries the condyle round its short arc on the eminence; (2) the downward and forward swing of the condyle, this movement centring on Lord's point; and the (3) radial swing of the whole sphenomandibular ligament which carries Lord's point sufficiently to the rear to clear the descent of the condyle.

I must not leave you with the impression that the sphenomandibular ligament swings around in the neck like a mechanical link: this ligament actually is a thickened portion of the cervical fascia, but it can swing in its own fashion.

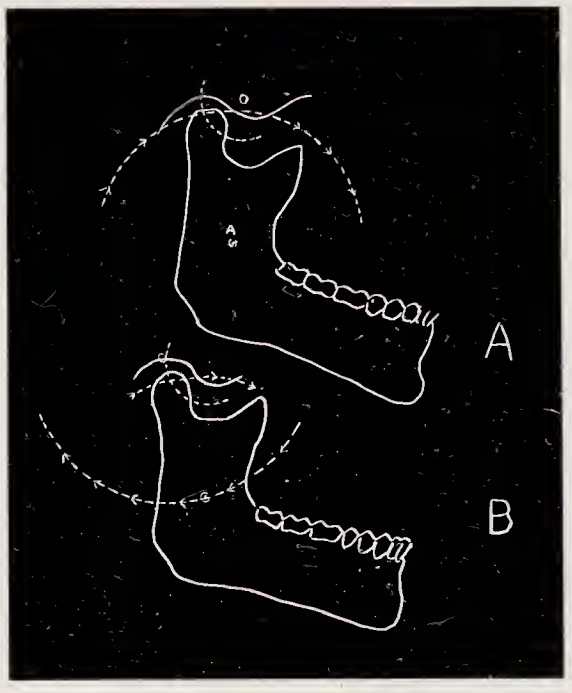

Fig. 6.—Shows that by swinging the mid-ramus axis backward, the condyle can clear the eminence.

THE PATTERN OF PAIN

In this paper, I deliberately avoided all reference to the character and treatment of facial pain: I felt obliged to leave the story untold rather than spoil it by inadequate treatment. However, I cannot resist the temptation to present to you another hypothesis, which on this occasion refers to the distribution of pain on the face.

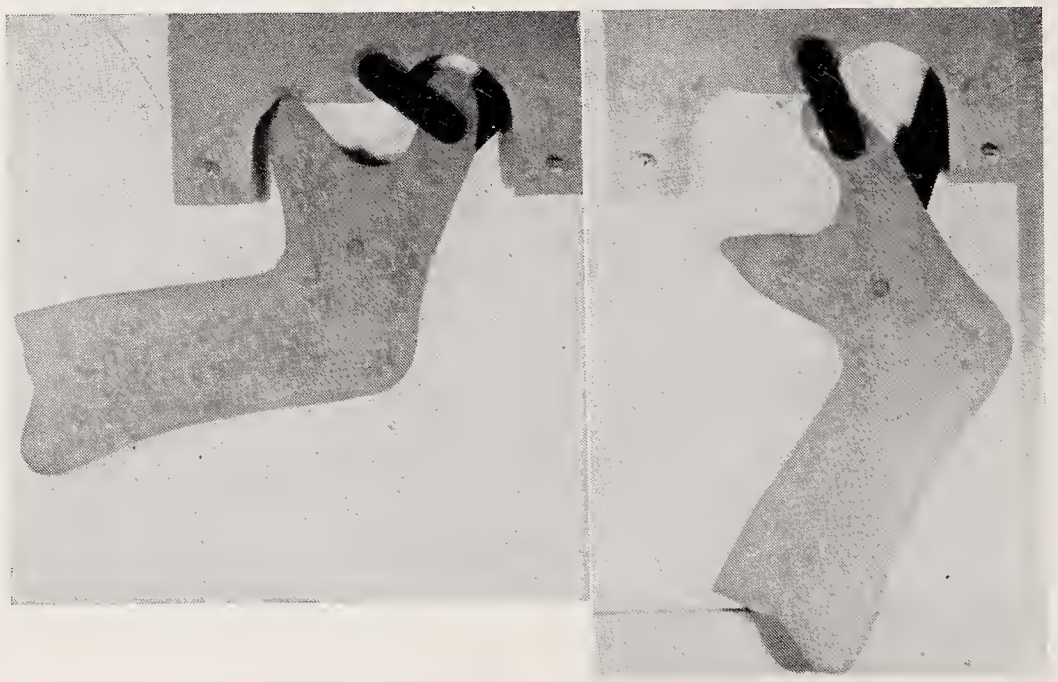

Fig. 7.—This plastic model shows the interplay of the three swings which enable the jaw to open: (1) the pivot on the mid-ramus point; (2) the swing of the joint ligament; and (3) the swing of the sphenomandibular ligament.

During the routine of taking the case-history of a patient suffering obscure facial neuralgia, the pain-pattern is drawn on a "pro-forma" diagram in red ink. This procedure was adopted in the hope that some significant feature would emerge.

These pain-pictures vary enormously, and so far most of the patterns defy rationalization.

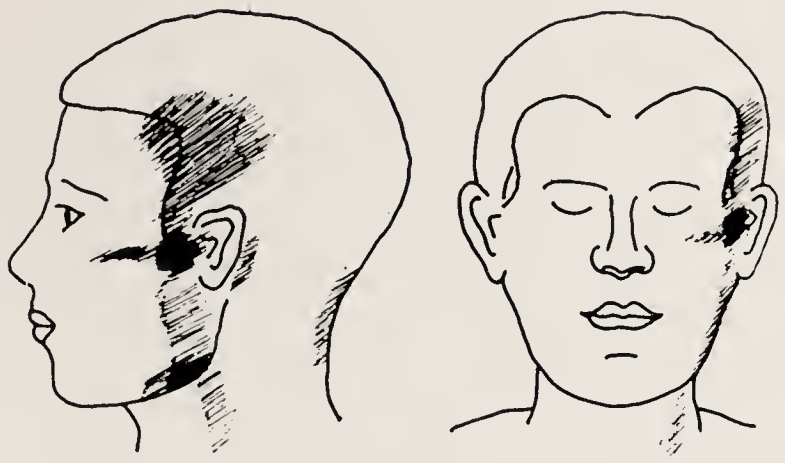

Fig. 8.—A common pattern of facial pain. This is not a composite.

However, a considerable proportion of our patients have complained of pain in the areas depicted in *Fig.* 8. I do not mean to convey that the picture is a composite of pain-distribution, one patient describing pain only in the temple, and another at the angle of the jaw: the point is that most patients suffer pain in every part which is shown hatched in the figure.

This typical pain-pattern could be interpreted in several ways. The neurologist could argue that the pain in the temple is caused by pressure of the condyle on the auriculotemporal nerve, and that the other areas involved the second and third divisions of the fifth nerve. Then the embryologist could find an explanation in the phylogeny of man. But if the temporal fossa contains the distribution of the auriculotemporal nerve, it also contains the temporal muscle. Indeed, if every area in our pain-pattern is examined, each will be found to have its connotations with muscles: the zygomatic arch gives origin to a muscle and the angle of the jaw has muscle insertions. The streak of pain down the neck could represent the extensor muscles of the jaw, and powerful back muscles are inserted in the suboccipital space, *Fig.* 8.

I reserve further comment on the subject of pain distribution to another occasion. The presentation of this paper draws to a close with two brief case-histories and a summing-up.

AN OBVIOUS CASE OF VERTICAL MANDIBULAR DISPLACEMENT

The case shown in *Fig.* 9 was selected for discussion because it depicts an obvious upward displacement of the mandible. While the teeth may have extruded a little, nevertheless we get a fair estimate of the extent of the patient's over-closure as he crushed his food, and here it should be said that he did not possess a partial denture. To cut a long story short, he was cured of neuralgia by the simple expedient of restoring his masticating level, *Fig.* 10.

Fig. 9.—The occlusion of Mr. M. He did not possess a partial denture.

Fig. 10.—The prosthesis which cured Mr. M.'s facial pain.

AN ORTHODONTIC CASE WITH WIDE IMPLICATIONS

A 16-year-old boy was brought because of bleeding gums around his lower incisors (*Fig.* 11): I was asked if orthodontic treatment would help. His caries-free dentition was complete, but the upper left central and lateral were deeply locked behind the lower incisors, and the mandible was evidently slewed to the left. There was a slight "postural Class III" forward displacement of the jaw when the posterior teeth were engaged. There was a loud "click" in the left temporomandibular joint. Without being prompted, the boy volunteered the information that he had suffered left-sided facial neuralgia for two years.

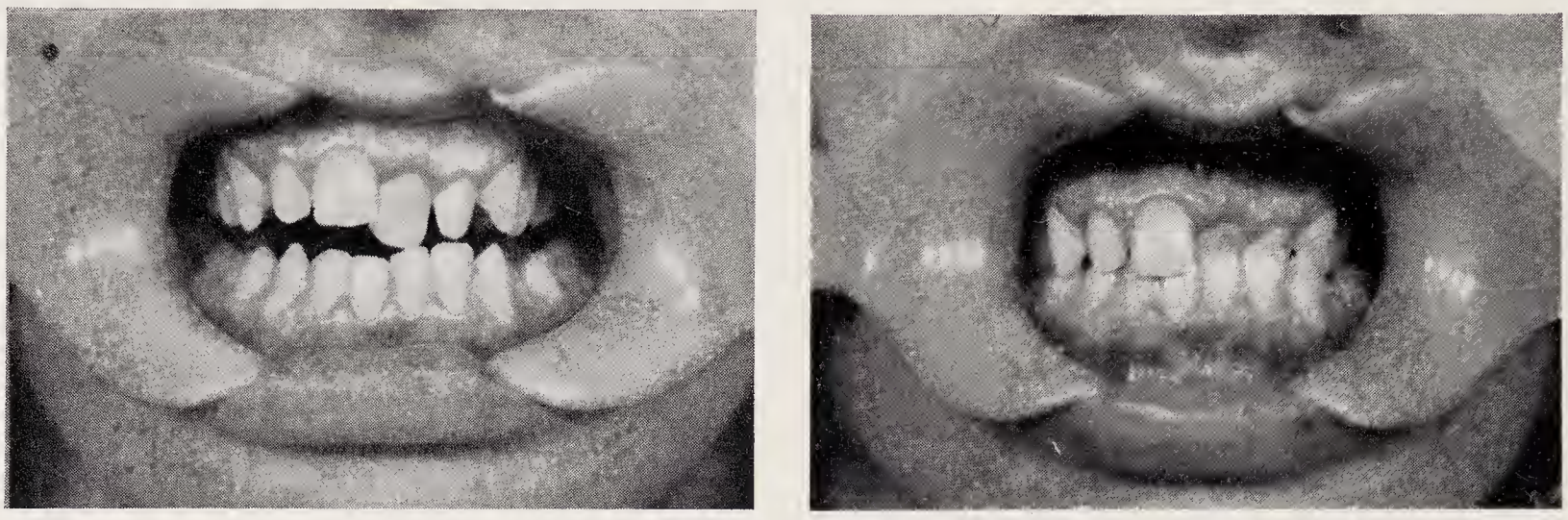

Fig. 11.—The incisor lock which caused temporomandibular pain in Mr. W.

Fig. 12.—Mr. W.'s neuralgia disappeared when his incisors were alined.

To my mind, this case integrates several factors. Many of our patients are high-strung like this youth. In many cases the neuralgia besets them when emotionally disturbed: the boy's emotion was the puny excitement of watching a football match. Then, the painful effect of cold wind on the face is a story we commonly hear: the boy felt pain on a cold, windy day. Furthermore, he was an orthodontic patient, a periodontic patient, he had a noisy joint and a horizontal displacement of his condyles. His face was asymmetrical.

Now, who should treat this young patient—the physician, the neurosurgeon, the psychiatrist, the periodontist, or the orthodontist? The short answer is that a few months of orthodontic treatment brought the upper incisors over the lowers, and the pain and "click" disappeared. *Fig.* 12 shows the orthodontic treatment partly completed.

CONCLUSION

This last case probably sums up my paper: it conveys the message that by training and outlook no dental specialist is superior to the orthodontist in suitability for this new task. However, if one can judge from the amount of literature devoted to the subject in the journals of the respective specialities, the periodontists, the prosthetists, and the maxillofacial surgeons have outstripped the orthodontists in the acquisition of knowledge of temporomandibular pain. To my mind, the orthodontist should enter this work: not only is he skilful in correcting occlusal anomalies, but an essential part of his duty is the visualization of the mouth of his patient years ahead.

In this paper, I have done no more than sketch in a few outlines which will be filled in on other occasions. My fear is that because of the condensed treatment of my subject, I may have left wrong impressions. As an example,

I would not have you think that malfunction of the temporomandibular joint is a more common source of pain than hidden dental decay. Also, I would like to make it plain that pain in this joint can often be tracked down to an impacted lower wisdom tooth.

There is a vast store of knowledge still untapped, and anyone who enters this field now is still a pioneer. The greatest inconsistency is why some persons have no pain despite the mutilation of their occlusions, and others who suffer have no recognizable temporomandibular joint symptoms, and, stranger still, a small percentage of the latter category have been relieved by empirical decompression of the meniscus. Verily, the subject is full of paradox and contradiction. These patients whose temporomandibular joints pass every test set us a problem. Is it worth while treating them? Frankly, I would say that in most instances it is a sheer waste of time treating a patient by mechanotherapy, unless positive joint symptoms are apparent; nevertheless it is a fact that a small number have received benefit.

As to the recruitment of specialists for this new therapy, it may be that some orthodontists will "swarm-off" from orthodox orthodontics to this new field of endeavour. I would strongly advise any who contemplate taking this step to consider wisely before committing themselves to what is probably the most trying specialization in dentistry. It is true that the majority of patients who have passed through our hands have been unusually intelligent and co-operative, but from time to time the clinic tends to fill up with human oddities whose talk and behaviour is most irrational.

The incidence of obscure facial pain is higher than commonly believed. These patients hardly ever consult the dentist, and, indeed, the doctor seldom refers the patient to the dentist; the knowledge that the dentist can help is too new to be widespread.

They do not all suffer to the same degree, but those who are most afflicted are pitiful objects. It is common to hear words of desperation on their lips. I have known some who have endured their pain for twenty years, gradually coming to accept their unhappy lot, existing only for the periods of remission that are characteristic of the disease. Yet several of this type have been cured by a few months of mechanotherapy.

Before I close, I must try to get the picture into true perspective: we cannot cure everyone. I could not promise a cure to any individual patient, but our results so far show that out of every 100 patients with the distinctive pain-pattern, a sober estimate is that 70 should receive benefit.

Facial pain is a problem of unsuspected magnitude, and of wide repercussions. Its victims will be found everywhere. The demand is there; someone will have to supply it. I anticipate that the day will come when every dental hospital will have a specialized unit to deal with the numbers of patients that the future will bring. For a long time it is likely that we will blunder in the dark, but if the next ten years sees an advance similar to that of the last decade, then the profession will have every reason to be proud.

Acknowledgements.—In the earlier pages of this communication I have already acknowledged the help and stimulus I have received from my colleagues. In addition I wish to thank Dr. Longmore of the Kodak Company, Professor Aitchison, who has been a continual source of inspiration, and Dr. Douglas, Chief Dental Officer, Department of Health for Scotland, who has done so much to further our researches. Finally, I gratefully acknowledge the help which we have received from the Scottish Advisory Council for Medical Research.

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DISCUSSION

Mr. J. Hopper, in opening the discussion, said that in estimating clinically anterior displacement of the mandible from the incisor relationship one should be inferring that the condyle was necessarily displaced downwards and forwards in closure. At Liverpool in a preliminary survey, about thirty postural Class III's showed no forward displacement of the condyle. Thorne (Sweden) out of 26 patients found 10 with normal rotational movement between rest and occlusion, 15 with slight distal displacement, and 1 with a slight forward displacement of $\frac{1}{2}$ mm. Did Dr. Campbell think that older age groups showed a higher incidence of true anterior guidance?

With regard to the decrease in vertical dimension and adaptation of muscle to this, Professor Le Gros Clark had, in a recent address, given grounds for believing that muscle was not so unadaptable a tissue as has been formerly believed.

Dr. Campbell had shown that the joint space anteriorly had remained the same throughout translation. However, in a paper recently published in the *British Dental Journal*, Rees had given evidence that the same area of the disk was not opposed to the condyle throughout its movement so one would expect the joint space to vary slightly according to the disk-condyle relationship; Dr. Campbell's opinion, in view of Rees's observations, would be greatly appreciated.

Mr. R. E. Rix asked whether Dr. Campbell had noted very many cases in which the symptoms arose from a distal displacement in Class II, division 1, cases.

With regard to the question of bruxism, he had once made an experimental monobloc for an adult and, owing to the way in which the upper and lower components of it were orientated, when it was placed in the mouth the lower jaw could not take up its true centric position. On insertion the mandible was thrown into violent lateral vibrations, which the patient could not control. It had been necessary to make adjustments to it in order to prevent these vibrations occurring.

Mr. A. A. Nove asked Dr. Campbell whether he believed that function of the oro-facial musculature was not confined within the boundaries of the face and that their range of functional activity was much more extensive.

Mr. R. J. G. Grewcock asked Dr. Campbell how he had arrived at his conception of the normal.

He thought that laminagraphy was excellent in the hands of Dr. Campbell and other experts but that there were other less expensive methods which have a definite place. The average general practitioner might find it easier to use oblique radiography of the temporomandibular joint rather than to buy the apparatus for laminagraphy, which, in any case, has its limitations.

With regard to taking the rest position by stylus, he felt that, when one took rest position, the less the mouth was cluttered up with things the better, and for that reason he did not like this method.

He regarded rest position as having a vertical dimension as well as an anteroposterior and lateral relationship, but Dr. Campbell referred to the gothic arch tracing which was done by means of sliding bites. He did not quite see how that could be done.

He thought that many of the cases of temporomandibular joint snapping were caused by a spasm of the external pterygoid muscle. He believed that the external pterygoid, owing to a disrupted normal path of closure, went into spasm and held the meniscus forward, so that the condyle in retruding was drawn back over its posterior lip. He suggested this because he had had several cases in which there had been premature cusp contact in the normal path of closure and the snapping noise had ceased within a few hours of the removal of the interference.

Bruxism in adults was very often due to an eccentric functional occlusion and adjustment to a centric mandibulo-cranial occlusion often eliminated bruxism immediately.

There must be thousands of people with mandibular over-closure who have no symptoms, and he agreed with Dr. Campbell that no treatment should be undertaken unless there were symptoms. He thought that many cases of temporomandibular joint disorders followed upon a general hypertonicity of the musculature, which, occlusion permitting, resulted in excessive retrusion of the condyles. It is noticed that so many of the people affected are women between the ages of 20 and 40, of the type which could be described as "hypertonic".

Mr. J. H. Hovell said that the question of facial pain was a very real problem to the general dental surgeon and to the consultant. He thought there was no doubt that in a certain proportion of the cases, at any rate, mandibular displacement was the cause of the pain.

Dr. Campbell had said in his paper that about 70 per cent of patients benefited from the therapy described therein, and he would like to ask whether Dr. Campbell had any more definite figures.

In these cases of facial pain there was frequently a very large functional element. Many of the patients were neurotic females. If a painful joint was immobilized it would be cured, but later on the patient would get eczema or a sore tongue, and it was the same with bite rehabilitation. Unless one could show a definite condylar displacement the patients would often be all right after treatment, but then they would relapse. He would like to ask Dr. Campbell in how many of the cases he had treated he would definitely attribute the pain to a demonstrable condylar displacement and how many of the cases relapsed later or had the pain replaced by some other functional disorder.

He had always regarded bruxism as the reverse of a mandibular displacement, which he thought was a reflex mechanism. Bruxism also was a nervous reflex: an attempt to grind away abnormal contacts of teeth during sleep.

Mr. C. F. Ballard said that Mr. Grewcock and he had suggested in a joint paper that much of the pain in the cases in question might arise in the muscles and not in joints. That suggestion had arisen from the concept that the rest position of the mandible was in fact the physiological postural position and that physiological postural position was not determined by the balance of resting tonus in the muscle but was a property of the central nervous system, so that if a patient was turned upside down the mandible would be still in the same relationship to the maxilla. If one accepted that, one might accept the idea that the pattern of motor activity of elosure was a property of the central nervous system. If, for some reason or other, the cuspal relationship interfered with this pattern of activity of the mandible they would disturb this neuromuscular mechanism. Such a disturbance was a reflex one, set off by afferent

stimuli from the nerve-endings in the periodontal membrane of the teeth with the offending contacts. These afferent stimuli produced the abnormal muscle activity which resulted in overclosure and pain—pain in muscles or pain in joints in the way that Mr. Grewcock has suggested.

Mr. H. G. Watkin said he would like to hear Dr. Campbell's views on the injection of alcohol in cases of tic douloureux. It had been his practice to inject an anæsthetic in such cases, and, if that relieved the pain, he replaced it with alcohol.

Mr. H. E. Wilson said that orthodontists must learn to recognize the mandibular deviations which in later years might produce the painful conditions to which Dr. Campbell had referred and which orthodontists could very often prevent.

He recalled a case, a girl aged 16, who had this acute joint disorder because she had four first premolars extracted earlier for orthodontic treatment, the upper incisors being retracted against the lower incisors producing a Class II, division 2, type of incisor relationship with a backward sliding contact.

He had rarely seen a Class III type of case with these acute symptoms, and he would like to ask Dr. Campbell whether in the Class III case which he had shown on the screen the symptoms had been due to the Class III relationship or to the lateral displacement.

Dr. J. Campbell, in replying to the discussion, said he thought that in many cases the orthodontist could foresee what was likely to happen in the future and realize that cuspal inclines which were just facing one another, might make contact at a later date, when some posterior teeth had been lost. The inclines might be disposed in such a way as to cause forward or backward or lateral deviation of the jaw.

He thought that the condyle in postural Class III cases did shift forward, and, during the closure of a postural Class III case, especially after the extraction of the superior supporting teeth, the condylar head might be forced against the slope, with compression of the meniscus. He thought that this compression of the meniscus was one of the causes of pain. The movement of the condyles might not be detected by measurement, though in the future, as a result of electromyography, it might be possible to measure such things.

He thought that the muscles could be painful. Muscles were painful when they were cramped. He agreed with what Mr. Grewcock had said about cramp of the external pterygoid muscle. This muscular cramp might occur particularly when there was an interference with the blood-supply. Seven times more women than men suffered from neuralgic pain, and one reason why the so-called neurotic woman was prone to neuralgia might be that the blood-supply to her muscles was not adequate.

He used alcohol injections to a considerable extent in the case of tic douloureux. If, for instance, there was an isolated spot of pain below the infra-orbital foramen, or if there was a locality of pain between the two mental foramina, he did not waste time in bite rehabilitation but he immediately injected novocaine, and, if the pain abated, he followed that up at once with an alcohol injection. The drawback to a peripheral alcohol injection was its fleeting effect, which was usually a maximum of nine months. He hesitated to use alcohol on a second occasion, because the scar tissue that was formed as a result of the first injection built up a barrier round the nerve.

As to Mr. Rix's point about Class II, division 1, cases, he thought that this also was liable to be a trouble-making situation as far as displacement of the condyles is concerned.

In reply to Mr. Nove, he would say that he had not dealt with function in his paper, because it was much too big a subject to introduce in the time at his disposal.

With reference to Mr. Grewcock's point about the rest position, until the date of Mr. Grewcock's visit to Glasgow he had always taken the pictures in the lying down position, which at that time was the only way that they could be taken with laminagraphy, but obviously a reliable rest position picture could not be taken if the patient was lying down. Dr. Campbell and his colleagues had had no difficulty, however, in changing their lying down table to an upright table. They had not done many rest positions yet, because it was only a few months ago that they had changed the rest position from lying down to sitting up.

He had arrived at his decision on normality of condylar relations partly by reasoning and partly by making a comparison of the histological specimen and the laminagram.

He agreed with Mr. Grewcock's suggestion that the general practitioner might use oblique radiography of the temporomandibular joint. He and his colleagues intended to use Mr. Grewcock's technique in that connexion to reinforce their own method, which was not sufficiently critical. Laminagraphy could show the function of the joint, but there was always a slight blurring of the image, so that one could not say that one bone was rarefied and another was not. They were beginning now to see bone changes as the result of treatment, so they hoped to use Mr. Grewcock's method.

He would not deal on this occasion with the question of "snapping", because there was so much that could be said about the cause of it.

With regard to Mr. Hovell's remarks, he would say that the eczema and all the other manifestations were merely separate expressions of some major systemic disturbance. Some patients might be cured by immobilization of the jaw. He would like to be able to immobilize many more of his patients than he did. If he could put them to bed for a month and immobilize them, he was sure that he could obtain quicker and more permanent results.

As to the question of relapse, when he began to treat facial pain he thought that many patients would come back after two years, but very few of them had done so. He built up the vertical dimension and tried to reposition the condyles. One condyle may be up while the other was in normal position. He tried to get the displaced condyle into position and to keep it there, but it might go back. He had been working on the subject for only seven years and he could not say yet what the relapse percentage would be.

With regard to bruxism, he had been very daring in referring to it as a neuromuscular phenomenon. He knew that the accepted term was "grinding of teeth", but he believed that bruxism could exist in edentulous cases, because the grinding of the teeth was merely the end-product of the neuromuscular phenomenon.

He agreed with Mr. Ballard's point about the muscles.

The therapy which he had dealt with in his paper was a new one and at present those who were interested in it were merely at the stage of accumulating knowledge about it. In putting forward his opinions he was attempting to contribute to the knowledge on the subject.

ORTHODONTICS: FIFTY YEARS IN RETROSPECT

By **HAROLD CHAPMAN**, F.D.S. R.C.S. D. Orth.

THE EIGHTH NORTHCROFT MEMORIAL LECTURE

Mr. President, Dr. Lindsay, Ladies and Gentlemen, I thank you for the honour you have done me by inviting me to deliver this, the eighth lecture in memory of our founder, George Northcroft. I am not unmindful of the fact that the preceding lectures have been scientific and that my presentation must be of a more homely nature—a brief review of orthodontics embracing the first half of the century, not all-embracing, but as I have seen it. This period corresponds approximately with the "orthodontic life" of "George" whom I knew so well for almost forty years.

There may be a number of members who did not know Northcroft, though it is only just over eleven years since he attended our meetings regularly. I would have hesitated to say how few knew him had not the Chairman of the Representative Board of the British Dental Association (B.D.A.)* mentioned last autumn when announcing the passing of Mr. J. H. Badcock, our first President, and a staunch friend of Northcroft, that he would be known to few in the room; this announcement caused me surprise but I was equally surprised to find it confirmed, so I will open with a biographical sketch of Northcroft as I do not think this has been given in open meeting, and make it complementary to the one in the 1943 Transactions by Dr. Lindsay, whom I take the opportunity of thanking on behalf of the Society.

BIOGRAPHY OF GEORGE NORTHCROFT

George Northcroft, born in 1869, was educated at Lancing College, Sussex, and the Leys School, Cambridge. He wished to become a sculptor but his father would not allow it, so he took up dentistry as another way of using his gifts; his interest in sculpture is apparent in that he was responsible for the acquisition of the statue of the Cumæan Sibyl, by Gilbert Bayes, which adorns the entrance to the B.D.A. library. His gift for carving in ivory is seen in the gavel he made and presented to the B.D.A. in 1920 for use by the Chairman of the Representative Board.

His career as a dental student was unusual for an Englishman in that he began it in the United States at the University of Michigan (Ann Arbor) whence he obtained the D.D.S. in 1890 at the age of 21. He returned to England, entered the Royal Dental Hospital, where he gained the coveted Saunders Scholarship for operative work, and qualified L.D.S. in 1892. The reversal of the usual order of dental education for an Englishman taking an American degree as an extra qualification probably enabled him to obtain both in four years, the minimum time required for the L.D.S. only; he may have done this on the advice of an American practitioner in London, W. M. Croll, with whom he was associated in practice at Windsor before establishing himself in London.

Northcroft was the first dental surgeon I met when I came to London in 1906; he lived and practised at 115 Harley Street, a house on a north-west corner. This meeting led to my association with him before going into practice on my own account in 1908, an association which I have always treasured on account of its influence on my own career and the lifelong friendship to which it led. An early reference to him in the literature is to be found in Smale and Colyer (1901), the standard text-book of my student days, where there is illustrated a simple pair of pliers (*Fig.* 122) designed by Northcroft to facilitate bending pianoforte wire.

* In referring to societies and journals the name is given in full followed by the initials, in the first instance, subsequently initials only.

Given at the meeting held on November 8, 1954.

The first reference to him in the Index of the Periodical Dental Literature is in 1891, and in the five years 1901 to 1905 there are seventeen. His first contribution I recall was to the annual meeting of the B.D.A. at Liverpool in 1910. It took the form of a collection of models illustrative of the Angle classification. Angle had not referred to the deciduous dentition in his classification—indeed I am not sure that he referred to it at any time—but in this collection Northcroft included models of the deciduous (or mixed) dentition; these he described as "foreshadowing" the various types of cases which made up the Angle classification of irregularities of the permanent teeth. At that time Northcroft had not the cases to complete the exhibit so he left gaps to be filled in, as newly found elements are included in the periodic table of chemical elements. This exhibit, somewhat damaged by bombing, is now housed in the London Hospital Museum and is probably the earliest demonstration dealing with abnormalities of occlusion of the deciduous dentition; until then it had been accepted that they did not exist; Northcroft was probably the first to correct this belief.

Badcock, in the first British Society for the Study of Orthodontics (B.S.S.O.) presidential address (1908) said: "At this time the dental world was supersaturated with orthodontic interest." In his valedictory address he said, "I shall be succeeded by Mr. Northcroft, than whom there is amongst us no man more able or more zealous". Northcroft's presidential address in January, 1909, was entitled "Aims and Ideals"—the very title gives a picture of the man. In it he appealed to members to preserve the models of young developing mouths, normal and abnormal; his demonstration in 1910 is proof that he practised what he preached. He made valuable series of models and face masks of his own children, from 25 days to 21 years; these alone mark Northcroft as a man of unusual operative and technical skill. His abilities, including initiative and organization, were recognized beyond the dental profession when the foundation of a Dental School at the London Hospital was contemplated.

This new dental school was the idea of the late William Wright, who was the Dean of the Medical School and Professor of Anatomy. He needed a dental collaborator and was fortunate to know Northcroft; these two brought Wright's dream to fruition in September, 1911, when the fourth dental school in London was opened twenty-three years after Guy's, which was the third. Northcroft was one of the six additional dental surgeons appointed to complete the staffing of the new school; he lectured on operative dental surgery, for which he was eminently fitted. He resigned in 1920. During this period the orthodontic charts were given the title "odonto-prosopic-orthopædic", a term Northcroft introduced because he considered it described the subject more completely than "orthodontics", but it was never accepted by the profession, perhaps because it was cumbersome, whereas the change from "orthodontia" to "orthodontics" made in the Society's title in 1909 has been accomplished completely, as witness its adoption in North America after this Society had made the change on the advice of Sir James Murray, philologist, of Oxford (1909 and 1932).

In 1933 Northcroft was associated with Professor Wright in the investigation of and report on the jaws and teeth of the Princes in the Tower whose tomb in Westminster Abbey was opened to verify the belief that it was actually the bodies of the Princes which occupied it. The examination, which included radiography, confirmed this and the ages at which they died, important evidence being supplied by the dental development; any doubt as to the identity of the individuals was dispelled as a result of their research. The investigation (*Archæologia*, 84, 1935) was referred to in the *Sunday Times* of August 23, 1954, by Mr. R. P. Howgrave Graham, who spoke of it as "a close analysis of facts which have not been discredited to my knowledge".

Northcroft was a consultant to military hospitals in London in the first world war, doing much in connexion with jaw injuries, for which he received the honour of the O.B.E. His lecture in the series instituted by the Dental Board of the United Kingdom, "Teeth

in Relation to the Normal and Abnormal Growth of the Jaws" (1924) contains much valuable information for orthodontists. He assisted Sir Frank Colyer in rearranging the collection of models relating to orthodontics in the museum of the R.C.S.; an account of this appears in our 1935 transactions. In 1927 he was president of the European Orthodontic Society (E.O.S.), and our president for the second time in 1929, the twenty-first anniversary of the Society's foundation. Northcroft played an important part in organizing and bringing to a successful issue the Second International Orthodontic Congress, held in London in 1931, of which he was Vice-President General and Chairman of the Reception and Banquet Committee. His partner, Mr. A. Garrow, writes: "He did much at that time to seal the friendship of orthodontists the world over", concluding "Dentistry was his first and last love".

This record of activities, in addition to carrying on a busy practice, would seem ample for any man, but he also did yeoman service for the B.D.A., the first of which I recall was as treasurer of the Metropolitan Branch in 1906. He was president of the Association in 1932 when it met in Canada, an office he filled with distinction. The University of Toronto honoured him and the occasion by conferring on him the LL.D. During the second world war, at the age of 70, five years later than many anticipate relaxation, he took on the treasurership of the Benevolent Fund and of the Prisoners of War Fund, both in connexion with the B.D.A. To this long but incomplete list must be added the Chairmanship of the Representative Board, a position he held from 1933 until the time of his death ten years later at the age of 74, a striking tribute to his mental and physical vigour. When considerably younger I heard him say he enjoyed "rude health" which is borne out by his activities. His exceptional skill as an operator and craftsman must be recorded; once when soldering and things were not going as he wished, I remember him exclaiming with some impatience "my hand has lost its cunning". O. N. Catchpole tells me that in conversation with him he spoke of dentistry as "tooth carpentry" and hoped he was a good carpenter. He designed and made a number of articles including the popular plaster plane, also shooting board, scriber, and tripod to be used with it, for model trimming, now displaced by mechanical trimmers.

I have been reminded by Friel that he was also a good critic; if Northcroft made no adverse criticism after he (Friel) had given a communication, he was well satisfied.

Northcroft had outside interests too: one was archæology. Evidence of this is in the lantern lecture he gave at the opening of the then new B.D.A. headquarters at Hill Street in 1936, and in the Smith Turner Historical Museum there, which he organized; he gave much time to arranging the specimens, the history of which he included in the catalogue he prepared; this work alone—it extended over years—would be an outstanding memorial to him. Other interests were work for the churches where he worshipped; he attended All Souls, Langham Place, W.1. for twenty-three years, where he had been churchwarden. He was a member of the Japan Society and collected ivories from that country. Golf was one of his recreations and at one time he was a keen stamp collector.

George Northcroft was generous and always ready to help, advise, and comfort. Dr. Lindsay tells me that on one occasion a young dentist showed him a puzzling case; Northcroft took the model, explained what should be done and described the appliance, ending with "It is rather complicated, I will make it and send it to you". I remember with gratitude what he did for me personally in many ways and on all counts I have a very great deal to thank him for. Remembrance of him is a stimulus to live up to the example which he set. To me his passing has been a very great personal loss.

STUDENT DAYS IN ENGLAND

Now I pass to another aspect of my address and return to the end of the last century when it was decided I should become a dentist. There were five dental schools in England, three in London and two in the provinces, Liverpool and Manchester, and only one

licensing body, the R.C.S. Eng. (In Scotland there were two schools, one in Edinburgh and one in Glasgow, and one in Ireland at Dublin; there was a licensing body at each, which gave the L.D.S.) There was no restriction of practice, a qualification being unnecessary. Dental mechanics was taught exclusively in the workshops of private practitioners until 1901 when it was also taught in the dental schools; for a time both methods were allowed; later it became compulsory for the entire course to be taken in a dental school. The decision that I should work for the L.D.S. Eng. having been made in 1898, there was no question but that I should be apprenticed under an indenture to a private practitioner in my home town. It will be apparent that what an apprentice learnt depended on the practitioner and it happened that I was in a workshop where no orthodontic appliances were made. Orthodontics, known as "regulation cases", was regarded to some extent as a part of dental mechanics, so I have no doubt that some of my contemporaries had experience in making regulation plates but I had none until I went to the Liverpool Dental Hospital in September or October, 1900. It was about this time that the workshop there (necessary for making the compulsory clinical prosthetic appliances) was enlarged to take "pupils" for the course in dental mechanics, so avoiding the necessity to do this in a private workshop. When this part of the curriculum (dental mechanics) was completed apprentices and pupils became "students" for the final two years' clinical course.

I recall making a Coffin expansion plate as a student. It was activated by a W spring made of steel (piano) wire, about 1 mm. diam., hence the Northcroft pliers. Before flasking, the portion of the spring inserted in the vulcanite had to be "tinned" otherwise the sulphur in the rubber combined with the iron of the wire instead of with the rubber, preventing vulcanization in that area; as a result there would be no rigid attachment for the spring which would work loose. The spring is named after its designer, C. R. Coffin, an American practising in London, but there is no record that he wrote about it. Coffin had been a pupil of Norman Kingsley of New York who wrote "Treatise of Oral Deformitics as a Branch of Mechanical Surgery" (1888). He, Kingsley, has been called "The Father of Orthodontics" (1908).

Stainless steel, which does not affect vulcanization, came into use later (approximately 1927); vulcanite was in its turn replaced by acrylics during the recent war.

Another appliance was the hickory peg, which is occasionally seen to-day in spite of its low efficiency.

My only other recollection of orthodontics whilst a student was an article in the *Dental Cosmos* (1902 or 1903), (since 1937 merged with the *Journal of the American Dental Association* (J.A.D.A.)), for many years the leading American dental journal, published by the S. S. White Company of Philadelphia, in which the word "Angle" appeared but I did not appreciate its application. A hospital appointment and nine months in private practice followed qualification but I do not recall seeing any children in the latter and certainly did not treat a regulation case. "School dentistry" was being talked of at this time, and on the initiative of George Cunningham the first school clinic was opened in 1908 at Cambridge with A. W. Gant as the first dentist. The project was financed by Sedley Taylor, who, Dr. Lindsay thinks, was a Professor of Music at Cambridge. Fisher of Dundee, another pioneer of school dentistry, advocated that children should not be admitted to school until they were dentally fit, in the same way as they are refused if suffering from ring-worm. What a help if orthodontic treatment were refused till patients were dentally fit otherwise.

STUDENT DAYS IN THE U.S.A.

A visit to the United States from 1904 to 1906 proved to have been made at a fortunate time. It came about as a result of friendship with H. C. Highton, a contemporary student also apprenticed in Southport, who later became the second treasurer of our Society, taking office in 1912, and president in 1927. At the time of our concluding the dental course at Liverpool, Matthew H. Cryer,

Professor of Oral Surgery at the University of Pennsylvania, and author of *The Internal Anatomy of the Face* (1901), visited Southport where he had relatives who brought him into contact with Highton. The result was that we decided to take the final year dental course at the University of Pennsylvania. Cryer's book, a small, well-illustrated volume, shows, among other things, the great diversity in size and shape of normal jaws, a subject worthy the attention of all orthodontists. It is interesting to recall that the voyage across the Atlantic on a crack Cunarder took seven days, a journey made as easily as a trip within Great Britain to-day—no passports, no currency restrictions, no visas; and the cost—£8 10s.! Grants were unknown in those days.

This period, the first decade of the present century, was an important one in the history of orthodontia, as it was then called. Dr. Edward H. Angle had been appointed to the Chair of Orthodontia in the University of Minnesota in 1887 at the age of 32. In 1891 he read his first paper to the 9th International Medical Congress in Washington, D.C.; this paper became the first edition of his book *Malocclusion of the Teeth*, and in the following year he practised as a specialist; in 1900 he published his classification and founded the American Society of Orthodontists (A.S.O.) and opened the Angle School of Orthodontia in St. Louis, Mo. Dr. Lindsay tells me he demonstrated at the annual meeting of the B.D.A. in Dublin, 1897, where he made many converts, her husband Robert Lindsay being one.

A. C. Lockett, an Englishman from Jamaica, who was to become this Society's first Hon. Secretary, 1908–11, was a fellow student at Pennsylvania and told me of the special six weeks' course Angle gave annually. Our study at Pennsylvania finished, we went out to the Middle West to take the Angle course towards the end of 1905. Twenty students comprised the class; two others came from Europe, Miss Carin Johansen from Finland, a member of our Society for many years until her death in 1953, and Josef Grünberg of Berlin, the inventor of the Grünberg blow-pipe, an important piece of equipment in prestainless-steel days; he also invented the symmetroscope which Friel improved. Grünberg returned at intervals to teach in the Angle School. Another fellow student was James D. McCoy, whose text-book *Applied Orthodontics* has reached its sixth edition; he still practises.

Less time was given to clinical work than I would have wished; perhaps this was inevitable as treatment could not be completed during the course. We were imbued with such enthusiasm for the practice of orthodontics that any one of us—we were all qualified dentists—who had a malocclusion, great or small, would have joyfully submitted to the treatment necessary to correct it, which confirms F. B. Noyes' (1931) remark, "He (Angle) had the great quality of kindling interest". Martin Dewey, author of the text-book *Practical Orthodontics* (1915) now known as Anderson's, was a demonstrator and for some years he conducted a private orthodontic school; he died in 1933 while comparatively young. The other demonstrator was F. S. McKay, who is still active and interested in mottled teeth and fluoridation. There is no doubt that at the turn of the century Angle dominated the orthodontic scene by his personality, idealism, and initiative, and through his students and his writings caused his influence to be felt far beyond the U.S.A.

APPLIANCES: GERMAN SILVER

The appliances used are all but unknown to-day; they were of German silver and consisted of screw clamp anchor bands and labial arches. The bands were contoured with pliers, burnished to fit the tooth, and the screw turned to secure them; this was found to be unhygienic, so later they were cemented. The gap between the two ends of the band left a portion of tooth exposed against which the screw rested; this was overcome in at least one make by leaving an extension at one end of the band to cover the gap so that no part of the tooth was exposed. The arch was a plain round wire, gauge 18, with threaded ends each carrying a nut which permitted adjustment of the arch length.

The resiliency of the arches was very poor and easily destroyed by heat, so that attachments to them had to be made with soft solder at the lowest possible temperature. The attachments were spurs and rubber band hooks, the spurs to enable teeth to be moved medially or distally along the line of the arch when tied to it with ligatures; the rubber band hooks were for intermaxillary traction. Lloyd S. Lourie invented a cutting pliers to raise the slightest sliver of metal in the arch to act as a nick to engage the ligature and so avoid the use of heat. Later the Angle arch had a labial rib added in which notches were cut to engage the ligatures; this avoided soldering or cutting which weakened the arch. Brass wire ligatures were used to attach the teeth to the arch to move them buccally or labially as well as medially and distally. Silk ligatures of Japanese grass line were also used to a small extent; they quickly became foul and were not satisfactory; this material contracted considerably when moistened. Patients were seen twice weekly to tighten the ligatures, a reflection of the lack of arch resiliency. A lingual arch soldered to bands was used for retention. This could be slightly activated without removing it from the mouth, by compressing it with a special pair of pliers which lengthened the wire. The removable lingual arch came into use much later.

APPLIANCES: PRECIOUS METAL

A new era soon followed: precious metals were coming into use for both bands and arches; these were made of special alloys of platinum, gold, and small quantities of other metals. The alloys have a high melting-point and, in wire form, a very high resiliency; they were a *marked* advance on German silver. Originally the alloys and the appliances made from them were obtainable only in the U.S.A. but in 1912 Friel was instrumental in having such band material and wire made in London by Messrs. Johnson, Matthey & Co., who were always ready to meet our requirements: I take this opportunity to thank them for their co-operation. Appliances, made for each patient by the practitioner, were superseding ready-made appliances. I do not know that any precious metal ready-made ones were ever made in England. The wire had to be annealed before working; loss of resiliency due to this and soldering was restored by heat treatment. I have read recently that certain stainless steels may be treated in the same way (Backofen, 1952).

The next appliance was the pin and tube, designed by Angle and described by him as the bone-growing appliance; originally a working retainer and later used as an active appliance. It was a thin precious metal arch perhaps with a loop between each tooth, having thin upright posts soldered to it; these posts engaged tubes on the incisor bands, the teeth being held more or less rigidly as the length of arch between each tooth was too short to permit any worthwhile resiliency. Other multiple band appliances followed, e.g., the ribbon arch, the next in succession, which rested in slots in brackets attached to the incisor bands, the brackets were pierced to take the lock pins which held the arch in position, the pointed end of the pin being bent over so that it could not come out adventitiously. This arch was succeeded by others of a similar type. Such appliances deprived the teeth to which they were attached, usually all the incisors at least, of freedom of movement, which seems physiologically unsound, as the supporting tissues are deprived of their function.

The removable lingual arch was introduced about 1920, and with its auxiliary springs was a revolutionary advance. The arch itself, especially if it incorporates a loop of finer gauge (whereby the anchor teeth are held less rigidly), as well as the springs, is used for tooth movements. There can be few here who have known a time when the lingual arch was not available, so it is difficult for you to visualize life without it. The late John V. Mershon had much to do with its evolution; it reduced the frequency of visits to six to eight weeks. Mershon addressed this society at a specially arranged meeting in 1925.

In 1927 Lucien de Coster of Brussels also made what has turned out to be a revolutionary change by using stainless steel for the construction of appliances. In the foreword

of his book *L'Orthodontie a base d'Acier* ("The Use of Stainless Steel in Orthodontics") (1935) he gives it high praise: "not only is a new material used, a noble metal, noble not by its chemical composition but by the extraordinary qualities revealed by its use. From the social point of view my wish is to put orthodontics within the reach of the masses." De Coster (1933) gave a demonstration and read a paper on "The Use of Rustless Steel in Dento-Facial Orthopædics" at the second international orthodontic congress in 1931; as a result, Friel went by air to Brussels in the autumn of that year to investigate the use of this material and from that time developed its use, ultimately abandoning precious metal. This change was probably hastened by the increased price of gold and other economic factors. From this beginning stainless steel has almost entirely replaced gold in this country, though in the States it has not been taken up so universally. The fabrication of steel appliances is entirely different from that for gold, and both are in marked contrast to German silver. The resiliency and strength of steel and the very small gauges in which it can be used and the slight continuous force that can be exerted for the actual tooth movements make it a most suitable material. Two months or more between appointments is not unduly long—contrast this with the time when two visits a week were necessary.

EDUCATION AND PUBLICATIONS

Since the beginning of this century orthodontics has presented, and continues to present, difficulties to those arranging the dental curricula in the schools. In the States private schools other than Angle's appeared but I doubt if any exist to-day, their place having been taken by the comprehensive post-graduate courses, some extending over one or two academic years, given by a number of the dental schools.

In 1923 A. LeRoy Johnson gave ten lectures to orthodontic teachers at the University of Pennsylvania on "The Basic Principles of Orthodontics". These lectures merit attention; they deal largely with the theoretical aspect with helpful comments on extraction. In the course of them he said, "There is no doubt the form of bone can be modified by physical force within certain physiological limits . . . but the bare phrase that 'bone grows as the result of mechanical stimuli' does not suggest these very definite limitations and the failure to recognize this has been responsible for much of our trouble in treatment". A colleague who has read these lectures recently, gave me his opinion of them: "They contain the fundamentals of orthodontics presented in good perspective and are as valuable to-day as thirty years ago when there was less specialized research."

It is a remarkable coincidence that Axel Lundström's monograph "The Problem of the Apical Base" was published in the same year (1923); he came to the conclusion that the dental arch could not be expanded beyond the apical base; thus they confirmed one another.

Orthodontics is recognized as a speciality by the legislature in six states of the U.S.A. In these, specialists are licensed as such; general practitioners are not precluded from orthodontic practice but are restricted from representing themselves as specialists (Wylie, 1951). The first law regulating the practice of orthodontics was passed in Arizona in 1929 as the result of the efforts of two of Angle's former students. In the same year the American Association of Orthodontists (A.A.O.) created the American Board of Orthodontics (A.B.O.) under a resolution of Dewey. This may be described as a subsidiary of the A.A.O. It acts as an examining board and issues a diploma to successful candidates; there are certain requirements, one being a thesis based on original work; no course of study is prescribed. The Board has no legal authority. There are several such "Boards" of the specialities of medicine in the States but orthodontics is the only dental one.

In 1931 the Dental Board of the United Kingdom instituted short post-graduate courses on various dental subjects for general practitioners, one of which was orthodontics; the latter was given at the London Hospital Dental School. This was perhaps the first post-graduate orthodontic teaching in England, though some practitioners had given

instruction privately. This course was continued by the School until 1938; the course arranged for 1939 was abandoned on account of the outbreak of war.

The University of California (Wylie, 1951) has sought to overcome the problem of undergraduate orthodontic teaching by arranging two curricula for qualification, either of which the regular dental student may elect to take; one is the ordinary curriculum from which orthodontics as a principal subject is excluded; in the other orthodontics pre-dominates, being taught for three years to the exclusion of prosthetics, which is limited to some basic instruction in the first year. A large majority of those electing to take the "orthodontic major", as it is called, have become orthodontic specialists. This arrangement seems worthy of consideration by other teaching bodies because of the great value of the long continuous clinical training; even in a graduate course this is not so favourable. It is significant that in the school year 1950–51 thirty-two dental schools out of forty in the U.S.A. gave training in orthodontics additional to that for qualification. Similar developments on a smaller scale are taking place here and in one instance the course has been taken to the practitioners.

It seems that every dental school in the U.S.A. has a Professor of Orthodontics; in addition some have one or more Associate Professors and a considerable orthodontic staff. The only Professor in the British Isles is Professor Friel of Trinity College, Dublin, elected in 1941, but the University of London made a step in this direction in 1951 when it appointed the late Miss K. C. Smyth a Reader in Orthodontics; this Readership is tenable at the Royal Dental Hospital of London. The Dental Council of the London Hospital Medical College in response to a letter of Oct. 29, 1923, accepted the proposal that a dental surgeon be appointed to practise and teach orthodontics only; it did not follow that the other dental surgeons could not be in charge of orthodontic cases. In 1948 the Faculty of Physicians and Surgeons of Glasgow instituted a diploma (D.D.O.); the first examination was held the following year, and this year (1954) the Royal College of Surgeons of England has done the same and instituted the Dip. Orth. R.C.S. Eng. Other qualifications, not entirely orthodontic but in which orthodontics may be the principal subject, are the M.D.S. of British Universities and the H.D.D. Edinburgh.

Smale and Colyer in successive editions give considerable space to orthodontics in their text-book, and Bennett, in his *Science and Practice of Dental Surgery* (1931) wrote three chapters (IV, V, and VI) himself which are a mine of information on all aspects of orthodontics other than treatment. F. W. Craddock (1953) believed him, Bennett (1908), to be the first to refer to the freeway space, and in a private communication (1951), says of him: "I find him always sound and in many things ahead of his time". Bennett includes in both editions (1914, 1931) of his book a table showing the possible combinations of the variables in anteroposterior relationship of the dental arches which may bring about the different types of post- and pre-normal occlusion, thus anticipating the "skeletal pattern" of to-day; there are four which would come under the heading of Class II, Div. 1 (Angle). Bennett was president of this Society in 1914 and Chairman of its Nomenclature Committee in 1926; the report is included in his book.

The Medical Research Council published in 1932 *Facial Growth in Children* (Smyth & Young), and in 1937 *Investigations into the Nature and Characteristic Features of Post-Normal Occlusion* which had been carried out by Miss K. C. Smyth and others. Sir Norman Bennett may have suggested this subject for research in the first instance and to facilitate it modified the Sim Wallace–Northcroft prosopometer, later improved by Friel.

Sim Wallace, president of this Society in 1910, wrote several monographs. I was impressed with his *Prevention of Dental Caries* (1912); his teaching unfortunately is neglected to-day, perhaps because it is too simple in application. He also published *Irregularities of the Teeth* (1904), and won the Cartwright Prize, R.C.S. Eng. with his essay "Variations in the Form of the Jaws" (1927).

Numerous publications from abroad have appeared, particularly from America, Europe is well represented by books from many countries.

CONGRESSES AND SOCIETIES

There have been two international orthodontic congresses—the first in New York in 1926 under the presidency of Wm. C. Fisher of that city, who was probably the leading figure in bringing it to fruition. Five years later, though in declining health, his dynamism was a factor in the promotion of the second congress, organized and held in London under the presidency of J. H. Badcock. Fisher attended the meeting. Undoubtedly it was in the minds of the promoters of these two congresses that one should be held every five years, following the lines of the International Dental Congress, but, whilst Fisher (1927) was a link between the first two, no one person came forward, nor was an organization created (such as the F.D.I., which meets annually to maintain a nucleus from which each quinquennial dental congress springs) to carry on the tradition. This was disappointing but perhaps not surprising when it is recalled that in 1926 the membership of the A.S.O. was approximately 250—probably all specialists—while in the British Isles in 1931 there may not have been more than six, certainly they could be counted on the fingers of two hands, and perhaps fewer still in other countries; Fisher (1927) said in 1926 that "there are nearly 450 specialists in the United States, 54 being in New York City, and in England 3, France 3, and Germany 3; the figures may not be absolutely correct but sufficiently so to call attention to the discrepancy in numbers". Neither the President nor the Vice-President General of the London Congress were specialists, so this speaks volumes for the enthusiasm of that body of general practitioners and a few specialists on this side of the Atlantic who had the courage and ability to make a specialized dental congress a success. These figures emphasize the difficulty of finding a country other than the U.S.A. in which to hold a third congress; France was probably the only other which had an orthodontic society at that time. The large volume of Transactions testifies to the quality of the proceedings.

The first orthodontic society, the A.S.O., was founded in 1900 at St. Louis, Mo. The E.O.S. followed in 1907 in Berlin, the first scientific meeting being held in September, and the B.S.S.O. in London later the same year with the first scientific meeting in January, 1908. There was not another in Europe until the foundation of the French Society, La Société Française Orthopédie Dento-Faciale (S.F.O.D.F.) in 1921 at Lyons. The Orthodontic Directory of the World, 1952, gives a list of thirty societies so, in thirty-one years, eighteen new societies have originated in seventeen different countries. A summary of the location of these thirty societies is: Europe eight, North America nine (the A.A.O. and its eight component societies), Central America two, South America five, Japan two, and one each in Australia, New Zealand, Cuba, and Israel. Details of some of these societies are of interest.

Dr. Edward H. Angle founded the A.S.O. and was its first president. It is a national society and the largest. A plan of re-organization was adopted in 1933 which provided for seven component societies; some were already in existence as independent societies, e.g., the Southern Society of Orthodontists (1921), and the Pacific Coast Society. In 1951 the New York Society, another component, was replaced by two societies, which makes a total of eight components. They have a large degree of autonomy and some, if not all, meet as the B.S.S.O. does at intervals during the year. They have associate members, young orthodontists who are elected to active membership as soon as they are eligible as to length of practice, etc. Doubtless Fisher would be pleased with this affiliation of societies in his own country.

There are a number of local orthodontic groups, perhaps fifty, in the States, which are entirely independent, e.g. the Chicago Association of Orthodontists founded in 1928 with eighteen charter members; now there are about one hundred, the majority of whom are members of the A.A.O. Some of these groups are study clubs (Baker, C. R., 1954).

The A.A.O. changed its name from A.S.O. in 1938; it meets once a year (in 1954 for five days), the programme listing fifteen papers, a panel discussion, thirty-two demonstrations, and an exhibit of twenty case reports.

The E.O.S. merits our attention. There were ten charter members, four of whom had been at the Angle School, W. G. Law in 1903, Miss Jane Bunker and M. Pfluger in 1904, and J. Grünberg in 1905. Another charter member, Axel Lundström, spent time with Angle but was not at a session of the school. Five of the ten were probably Americans practising in Berlin. The society had several names before adopting its present title (European Orthodontia Society 1907–14; European Orthodontological Society 1923–34), and brings together those interested from many European and North and South American countries, not all of which have an orthodontic society, so making possible very wide interchange and spread of knowledge. The first meeting was held in Berlin with W. G. Law as president. His opening address (1908) is interesting today; I have extracted the following sentences: "We feel sure that in a few years this society will have grown to be a power for good among the scientific societies of the world." "We have not limited our membership to any one nationality." "The malocclusion of Class II has been the greatest difficulty to solve." Law followed his address with a paper on "The Retention of Class II Cases—The Staple and Hook Sectional Retainer" (1908).

The E.O.S. transactions of that period, published in Vienna, were in German and English: Friel showed a complete set, which he believed to be the only one, at the 1954 meeting.

The foundation of the E.O.S. dates from a time when the world and its amenities were free to all; the difficulties of conducting such a society have increased enormously, especially in the realm of finance, so the officers, past and present, are to be congratulated on its vitality, on the success of the meetings, and on the production of the transactions within a year of the meeting. In this connexion my memory of the officers is not as good as I would wish but of more recent ones I would mention the late cosmopolitan O. Henry, treasurer and editor, 1929–48; the late urbane G. F. Cale-Matthews, secretary, 1933–38; the humorous Russell Marsh, secretary, 1938–49; and the late Miss K. C. Smyth, editor, 1948–53. Fisher (1927) visualized the E.O.S. as the parent of the various European national societies; world conditions now make such a project more difficult of realization than when he spoke but he would be happy to know that in practice the E.O.S. functions as an international society with some of his own countrymen on every programme, which reflects the thought and practice of many countries, east and west. That it survived two major wars speaks well for its future, though it nearly succumbed as a result of the last one.

The fourth society, S.F.O.D.F., was founded in Lyons in 1921 with sixty-two members; in 1953 there were three hundred and four, one hundred and thirteen being "titulaires" (the B.S.S.O. membership in that year was three hundred and sixty-six). The meeting is held annually at Asçension for several days and an excellent volume of transactions is published before the following meeting. The leading figure from its inception was Dr. James Quintero, of Lyons, who passed away in February this year, 1954. He was a quiet unassuming man and an excellent linguist. From time to time this Society meets in an adjoining country, in a number of which it has members. Its membership consists of two classes, Membres Stagiaires and Membres Titulaires, the former are those who have just been elected and who have not read a paper or given a table demonstration, their status as orthodontists is unknown. To be elected Membres Titulaires they must have attended two consecutive meetings and have read two original papers and given four table demonstrations. When this has been done, the Committee decides if the quality of the work presented is such that they should be proposed to the general meeting as Membres Titulaires. These have not an orthodontic degree; whilst they need not be specialists they are almost in that class; only these have the right to vote.

The Dutch Society is the youngest but one in Europe. It was founded in October, 1946, with 196 members, five of them specialists.

It is worthy of note that the population of Holland (1951) was under $10\frac{1}{4}$ millions, but for its size is a country with a number of dental societies and one in which the spirit of professional association is high. The first meeting was in Utrecht and very well attended by Dutch dentists; several orthodontists from other countries gave addresses. The Society now has a membership of 215, fourteen of them specialists.

JOURNALS

Shortage of space necessitates the omission of paragraphs, included in the original, dealing with the well-known journals *Amer. J. Orthodont.* and *Angle Orthodontist.*

The B.S.S.O. has always arranged for the papers read before it to be published in a periodical as well as in a bound volume issued to members annually, but now it is the only one of the four first established societies to do so. This greater publicity is synonymous with a wider spread of knowledge and in our own case the cost of the annual volume is reduced which in turn means a smaller subscription than would otherwise be the case and may have a favourable bearing on the number of members. For record purposes I mention the fact that the *Dental Record* published our Society's transactions, including discussions, from the first general meeting in January, 1908, to December, 1944, and later bound them in book form annually for issue to members. In 1908 the *Dental Record* was owned by the Dental Manufacturing Co.; in 1947 it passed to the printing firm of Messrs. Saward & Co., Honduras Street, London, E.C.1. During their ownership discussions were omitted. From January, 1954, the DENTAL PRACTITIONER, established in 1950, took over the printing of the papers and discussions.

The French Society (S.F.O.D.F.) started publication of its proceedings similarly, the papers appearing first in *La Province Dentaire*, edited by the late James T. Quintero. On his initiative the entire proceedings were collected into one volume and published under the title *L'Orthodontie Française*, which is now the sole medium of publicity as *La Province Dentaire* ceased publication in 1938. Since 1944 its place has been taken by *Les Annales Odonto-Stomatologiques*, the official organ of L'École Dentaire de Lyon and of La Société Odonto-Stomatologiques de Lyon, of which Dr. Heskia is administrator and editor. He is also editor of *L'Orthodontie Française.*

The October, 1953, issue of the *Angle Orthodontist* contains a condensed article reprinted from the *Archives of Orthodontics*, 1952, **1**, 10–23. This publication originated with de Coster, who launched it from Brussels in 1948 as a small journal containing digests, in French and English, of the world's orthodontic literature; it was a valuable addition but unfortunately its life was only two years (four issues). An attempt to resuscitate it has been made in America but so far it has not been a success.

The *Fortschritte der Orthodontik in Theorie und Praxis*, a German publication from Munich, edited by Gustav Korkhaus, appeared in 1931 as a quarterly. It was very well illustrated and contained excellent summaries of the articles in French and English by Quintero. It was the first European orthodontic journal. The last issue was in 1933, when it seems publication ceased. In 1952 Korkhaus handed me a copy of *Fortschritte der Kieferorthopadie* (Jaw Orthopædics) (Vol. 13, No. 1) which contained orthodontic articles and was edited by him, but I have not seen any other issue.

CHANGES IN THEORY AND PRACTICE

It will be appreciated from what has been said earlier that by his personality, idealism, and initiative Angle dominated the scene at the beginning of this century; his influence can be traced in the A.S.O., E.O.S., and B.S.S.O., probably the first specialist societies of dentistry.

Angle's classification is as useful to-day as when he published it in 1900, if adapted to present-day knowledge; Bennett's classification (1914) is a valuable adjunct; they are complementary to one another. The idealistic belief, so strongly held and advocated by Angle, that teeth should not be extracted has proved unsound, though its realization by the profession as a body has taken many years and his teaching may persist many more if each practitioner has to learn it for himself,

as I have heard expressed—a sign of the force of Angle's teaching. The difficulties of making a decision—to extract or not to extract—are not so great as often made to appear. Some experience and study and a knowledge of developmental changes will go a long way to solve them. A series of cases showing relapse of expansion after treatment should convince those who are in doubt. Where relapse has not occurred, who is to say the expansion has been due to treatment, if undertaken during the developmental period, and not to growth? Increase in arch width occurs naturally during this period but to increase it still further by making bone grow is not possible.

I recall a consultation in which the dentist advised expansion rather than extraction and said the bone would grow to contain all the teeth. The child's uncle, a doctor, told the mother this was impossible, hence the consultation. As extraction was anathema to some, so non-extraction was anathema to others, the late Sir Frank Colyer (died 1954) for one, and in his jovial way he dubbed me "the arch expansionist": I little thought that in a few years I should agree with him.

A corollary of non-extraction was the calculation of the size an arch should be to contain all the teeth. It seems to have been an exercise to find or invent a method of determining this. G. G. Campion (1908), our president in 1920 and of the B.D.A. in 1923, and Pont, of Lyons (1928), each published formulæ, the calculation being made from the size of the upper incisors. C. A. Hawley, of Washington, D.C., U.S.A. (1905), using the same basis, drew empirical geometrical figures which resulted in "the arch" for the particular case (in the early days I always did this), all arches were the same pattern, no variation was made for individuality such as a dolicocephalic or brachycephalic person. Cryer's illustrations were disregarded. "Hawley diagrams" on celluloid were obtainable to avoid the necessity of drawing one for each case; by placing the "pattern" over the model the extent of tooth movement needed could be seen at a glance.

Körbitz (1911), in Germany, designed a lower arch for the same purpose. F. L. Stanton, of New York (1915), a fellow-student at the Angle School, in conjunction with an engineer named Hanau and using engineering methods, made most elaborate calculations to produce the ideal arch for the particular case. More recently Ballard and Wylie (1947) have devised a formula to estimate the size of unerupted permanent teeth.

Even since I have been aware of the necessity of extraction in those cases where basal bone is or will be insufficient to contain all the teeth in line, I believe I have extracted in too few to give the best results; certainly I would extract more upper teeth had I to treat the same cases again, and I am much impressed by the frequency with which one meets the statement in present-day literature that the only bone changes that can be made are in the alveolar process. In this connexion my own belief, from clinical experience, is that the relation of the lower jaw to the upper can be changed in either anteroposterior direction by means of intermaxillary traction, the degree of force never to exceed two ounces.

It is strange to reflect that three beliefs as to the normal (held, say, in 1908) have been found to be fallacious. One was that irregularities did not occur in the deciduous dentition, another that the deciduous incisors erupted in contact and that spacing developed later, and the third that if the permanent incisors erupted in imperfect alinement they remained so. Therefore, one can hardly imagine a more important "discovery" than that normal occlusion during the developmental period had infinite variation—not just a static invariable appearance, arrangement, and arch relation; the permanent incisors on eruption can be in irregular positions but later assume good alinement, the arch width increases and the arch relationship may change. The lack of this knowledge may have helped to perpetuate the belief in arch expansion and may explain some apparently successful results of that treatment.

In 1922 C. A. Hawley told me that Class I cases were the most difficult to treat, which I have since interpreted as another way of saying that the expansion relapses after a period of retention; he said Class III were the easiest. I agree with him now, though at that

time my lack of experience led to a contrary opinion. The first occasion on which I advised not to treat a case with imbricated lower incisors was in 1925 (the patient's age was 7–10), when I had begun to suspect these mal-alined teeth were a passing phase of normal development. There is *no more interesting* study than the variations the normal may assume during the developmental period, and should be the first in the orthodontist's training.

I have mentioned Professor Friel, who is well known to you, but not all may know he was the first to specialize in the British Isles. I had intended to give an account of his activities as they extend over some of my fifty years and would in themselves be a record of the period, but the more I read the more I found to say, so I have to be content with a selection. Friel qualified in 1909, M.Dent.Sc., Trinity College, Dublin, and has added a number of other degrees since. He went to the Angle School in 1909 and started specialist practice in Dublin, February, 1910. Probably no one person has taught so many who have become specialist orthodontists. His contributions to the literature are numerous; the two he regards as the more important are the Northcroft Memorial Lecture, B.S.S.O., 1953, (1954), and "The Migration of Teeth" (1945); with these I include "Occlusion: Observations on its Development from Infancy to Old Age" (1926) read at the 1st International Orthodontic Congress; this should be studied by all. Soon after the first world war he went to Austria to study "The Effect of the War Diet on the Teeth and Jaws of the Children of Vienna" (1921), in which is shown his interest in physical development. He invented dynamometers for testing the strength of muscles and instruments to increase it. He has made the most complete collection of journals relating to orthodontics; I believe they are housed in Trinity College.

COMPARISONS

Research work to-day is a noteworthy feature compared with 1900.

Angle (1895) illustrated head and chin caps, little used then. Pollock (1954) in an editorial mentions that Carl B. Case read a paper at the A.S.O. meeting in 1912 on "Occipital and Cervical Anchorage" and that the same subject was presented at the 1954 meeting "Dental Changes Accompanying Treatment of Class II Malocclusions by Extra Oral Means" by Robert Warren Baker (not yet published); Pollock mentions that the discussion was much the same and that history repeats itself even in a very new speciality. This recalls a remark of Northcroft, that if one practised long enough the wheel went full circle; here are a few examples:—

Extraction; non-extraction; and again, extraction. Pollock, in the same editorial, writes: "There was no mention of extraction in that same programme (1912); the subject was taboo in that era and those extracting teeth were doing so more or less 'under the counter'."

Appliances: removable; fixed; removable. On the other hand, ready-made fixed appliances have given place to those made for the individual.

Steel (piano wire); platinized gold; again, steel (stainless). An advertisement of about 1905 (S. S. White Co. catalogue) is headed "Piano wire for Orthodontic Operation", "In the Coffin Plate it is a Necessity".

The prosopometer (1910) is the forerunner of cephalometry by X rays and was used in the research work sponsored by the Medical Research Council. Muscles are prominent in post-war literature; Friel did much work on this subject—on different lines—as related in his papers to the B.S.S.O. in 1924 and 1927. Opening of the maxillary suture was advocated about 1900 by Huet of Belgium and used by Dr. Lindsay about 1902; in 1954 M. Schwarz of Vienna brings it forward again.

No doubt other examples will occur to you all when you look back after fifty years.

As I delved into the past and found problems of fifty years ago still unsolved, I wondered if we had made progress, but it was not difficult to be convinced that we had. I recalled the advance in knowledge of the normal, which is the foundation of diagnosis, and a guide to what *not* to do as well as what to do, and I recalled the change in the wherewithal with which to do it. Then I realized

how far the student of to-day starts ahead of his 1900 eounterpart, a start whieh it is impossible for him to appreeiate. Let him not be diseouraged by these thoughts, there are other problems to be solved and, to use a favourite expression of Northcroft, he has the "assurance of youth" to earry him forward along the road of progress.

Dr. Johnson said that "what is said upon a subjeet is gathered from a hundred people", and those who have given me valuable assistanee in the preparation of this address are légion; may I ask one and all to aceept my sincere thanks.

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DISCUSSION

Mr. Howell Richards, in opening the discussion, said that the paper had given members some personal impressions of orthodontic development during some fifty years of practice. He was reminded of the radio programme 'You Are There' in which historical events were re-enacted with dramatic effect, with the difference that the narrator on this occasion really *was* there, and had been producing his effects for fifty years in his own quiet way. He had watched orthodontics grow from the 'very minor' branch of dentistry at the beginning of the century to its present importance as perhaps the only true speciality which could be separated from general dental practice.

The history had been most interesting, and as such was perhaps not as amenable to criticism as some of the more scientific subjects, but any orthodontic history of the past fifty years must include a great deal of Harold Chapman himself. That the paper had neglected this aspect was understandable, but he could not allow Mr. Chapman's natural modesty to go unremarked.

Mr. Richards said that if he might attempt to rectify some of Mr. Chapman's personal omissions, he would point out that from 1906, with a contribution to the Liverpool and District Odontological Society, to his Valedictory Address as retiring President of the British Society for the Study of Orthodontics in 1952, Mr. Chapman had made something like 76 contributions to orthodontic literature.

His subjects had left very few aspects of orthodontics uninvestigated and he had been published in orthodontic journals all over the world.

It would take a long time to mention Mr. Chapman's publications, but there were at least two results of his authorship to which Mr. Richards wished to draw special attention. The first was his section on orthodontic treatment in Bennett's *Science and Practice of Dental Surgery*, which comprised some 235 pages and would be a monument to any man. The other was a paper which appeared in the Society's *Transactions* for 1938 entitled "Failures in Orthodontic Practice". Mr. Richards said he knew of no other paper which specifically set out to inform its readers by admitting that success was not always the lot of the expert in the practice of his art, perhaps a little more reporting of, and discussion on, failures would be just as informative as the more usual accounts of success. It reflected Mr. Chapman's standing amongst his colleagues that he had not to consider any loss of prestige in choosing his title.

Mr. Chapman was a founder member of the Society and he was present at the meeting called by Northcroft on October 21, 1907. His close association with the affairs of the Society as well known, and he was Honorary Secretary from 1910 to 1925, a period equalled by Mr. Robert Cutler, who occupied the position from 1931 to 1946.

The honour of election as President twice was shared only with Northcroft.

Mr. Chapman took over the Treasurership in 1942, and the Society's accounts were in his safe keeping for the ensuing ten years, during which time any proposed expenditure had to be supported by irrefutable evidence of need before Mr. Chapman would append his signature to the necessary cheque. This, Mr. Richards said, was intended to convey to members the care which was exercised over the expenditure of the Society's funds and was in no way a reflection on Mr. Chapman's personality.

Mr. Chapman's knowledge of the early decisions of the Council had been invaluable to later members, and his readiness to help newcomers was perhaps known to few as well as to Mr. Beresford and to himself (Mr. Richards).

Mr. Richards said that Mr. Chapman's comments on changes in theory and practice presented decisions based on a lifetime of clinical experience. His remark with regard to extractions—that he wished he had removed teeth from the upper arch in more cases—could be well borne in mind when one strove by means of much apparatus and complicated techniques to move teeth in directions now considered rational and safe.

Mr. Chapman's belief in the possibilities of changing the relationship of the jaws themselves was still much disputed, though one might hope for some authoritative pronouncements with newer methods of investigation.

He could not find himself in complete agreement with the statement that Class III cases were the easiest to treat. Some Class III cases were quite easy—others were untreatable by orthodontic methods, which meant that several types of Class III abnormalities existed, and they were quite different in origin and in treatment.

Mr. Richards said it was re-assuring to him to hear that Northcroft was so helpful to his juniors, and following Professor Friel's reminder that Northcroft was a good critic—he thought the context was that if there was no adverse Northcroft criticism following a Friel communication, then he was well satisfied—he was reminded that his only personal recollection of the great man was that he seemed rather hard on junior members in discussion. He was glad to be informed that his impression was inaccurate.

He said that members had had the great names in orthodontics brought to their notice, not only as scientific observers, but as personal friends and acquaintances of their speaker.

Their techniques indicated that there was little which had not been tried before, and their ingenuity was remarkable. All in all, one obtained the impression that many of their problems still remained to be solved in spite of the modern aids available.

Mr. Richards said that it remained for him to congratulate Mr. Chapman on his most interesting treatise, which was both stimulating and informative.

Mr. H. E. Wilson said he had enjoyed the lecture, and was pleased at being asked to take part in the discussion. He had been associated with Mr. Harold Chapman for some years; his association might not be as long as some, but few could claim a closer one. One must inevitably gain, as he had done; he had learnt much which otherwise he could only have learnt from his own experience.

In the introduction to his lecture Mr. Chapman had said it was not of such scientific nature as previous Northcroft lectures, but it had been pleasant listening to a history of orthodontics by one so closely associated with it. Angle had been mentioned, and Case had not, but, Mr. Wilson said, he often thought what a different story it might have been if Case had had Angle's personality and drive, for his ideas were more in harmony with ours to-day.

Mr. Wilson said there was a lesson to be learnt from this lecture. During his lifetime Mr. Chapman had seen the pendulum swing backwards and forwards. He had mentioned Pont, Campion, Hawley, and their indices and diagrams; Mr. Wilson hoped members would bear with him if he quoted Milo Hellman (*Amer. Orthod.*, 1911, **2**, 162), because it was germane. Criticising some so-called research, Hellman had said: "So according to Schroeder all normal breathers must have the measurements given by him, and according to Hawley, all normal dentitions must assume the form of his diagram. Truly scientific. We can just imagine what form the human being would assume if the rest of his economy would be similarly regulated."

He thought that criticism was true to-day of some of their cephalometric diagnostic techniques. Hellman's advice to the research workers was: "They would further profit considerably if they would follow the example of the successful business man. It seems most probable that what has been found practical in business may, under these conditions, be highly profitable in research work, viz., that all investigators keep a well-arranged 'balance sheet' and check off their debit as well and as assiduously as they do their credit, and not keep on adding to that column which works to their advantage." That advice is as sound to-day as it was in 1911 and is just as much needed.

The change of jaw relationship in Class II cases was mentioned, and he agreed with Mr. Chapman. There had been evidence in support of the idea that the jaw relationship could not be altered, but that was not proof. The theory had arisen, he thought, in Illinois, and it followed that if jaw relationship could not be altered it was useless doing early treatment. It was interesting, therefore, to quote from Brodie's most recent publication (*Angle Orthodont.*, 1954, **24**, 15); he said ". . . my own answer to the question of when a malocclusion should be treated would be the same as for almost any other abnormal condition or disease, namely, when it is seen. The object of early interference is not treatment but (1) the removal of factors which are slowing growth, (2) the prevention of the seemingly inevitable result of a lack of harmony between the eruption of the teeth and the growth of the jaws, and (3) in Class II cases the adjustment by growth of parts that are out of harmony in their relations to each other."

Early intervention! Early treatment! Are they not synonymous? (1) So growth could be changed. (2) He was not sure what this meant; it was a general statement which might mean anything or nothing; it might include prophylaxis, or serial extraction, or even "timing"; it might only mean that the variations from the "average" were recognized. (3) It must be remembered that the dento-alveolar structures could be altered at any age, so this statement must refer to the jaw relationship. Was the pendulum beginning to swing again?

That, then, was the lesson—an important one and timely. History kept repeating itself. If Mr. Chapman had any advice to offer the younger members, Mr. Wilson said, he thought it would be to be more critical, more critical of one's own thoughts and writings, more critical of what one reads; not to accept everything one hears or reads no matter how dogmatically presented. In talking of the abnormal and variations of basic be sure the normal and basic are understood.

He would like to ask Mr. Chapman one question. He had spoken favourably of the University of California introducing the "orthodontic major" in the undergraduate curriculum. Mr. Wilson wished to ask if Mr. Chapman seriously considered this a good thing; if so, he would disagree with him. Too early specialization was a bad thing; orthodontics was not apart from dentistry, but was a part of dentistry. The broader the foundation the safer the superstructure.

Mr. Chapman had mentioned that the E.O.S. had survived two world wars, but its survival after the second was in no small measure due to Mr. Chapman's own efforts.

He would like to congratulate Mr. Chapman on his fine paper, which must be the climax to a long and successful career.

Mr. Pringle, who remarked that it had been a great pleasure to listen to Mr. Chapman, said that he had had some "ifs" in his mind; for instance "If things had been different".

What he had often wondered was how things would have continued if Angle had never started. When one read the English and American writers just before his time one found that they were very sensible and very near to English thought as it had developed since.

The other "if" was a serious one to teachers. He had been wondering about the history of Bennett's classification. If Bennett had reversed the order of his Group I and Group III, starting with general and putting his local causes last, there could have been a classification

which was really fundamental. However, by starting with the local causes Bennett seemed to have put the emphasis in the wrong place. He had often wondered whether that was discussed at the time that Bennett formulated his classification.

Mr. O. N. Catchpole said that he had been associated with Mr. Chapman for many years and thanked him for his paper.

His association with Mr. Chapman started when he was a student. Shortly after commencing practice, he encountered an orthodontic case, and asked Mr. Chapman about some postgraduate teaching, saying that he "knew what to do and only needed to be taught how to do it". A look of scepticism came over Mr. Chapman's face, but with his innate politeness, nothing was said. As the years went by Mr. Catchpole said that he understood more and more the reason for that look.

Mr. Norman Gray thanked Mr. Chapman for his paper, which he described as a paper from an older man's lifetime's experience. He said that it raised some of the great principles of orthodontics which many younger men might do well to follow.

Great names had been mentioned. He thought that Dr. Angle was unquestionably the father of world orthodontics, having taken the first steps in classifying malocclusions. Angle had been criticized tremendously, but he at least put orthodontics on a more scientific plane. When he was in Philadelphia, his teacher, A. LeRoy Johnson, also criticised much of Angle's teaching, but still revered his memory as a courageous pioneer. Angle still provided a tremendous stimulus for the students of to-day who are the leaders of to-morrow.

They had heard of another pioneer, George Northcroft. How deeply Mr. Chapman revered him! There had been tremendous jealousies amongst orthodontists; it was fitting that there should be stirring acts of hero worship, too. We, who follow on, profit from the pioneering work of the early days.

Mr. H. Watkin said that, as one of the oldest members in the room, he could not let the opportunity pass of adding his thanks to Mr. Chapman. He had known Northcroft, Badcock, and Friel personally.

With regard to Mr. Chapman's illustrations, he had taken one case through until the age of 18 or 19 and had then found that there was a relapse. He imagined that that was suggesting that in his older age Mr. Chapman would do some extractions earlier.

Mr. R. E. Rix congratulated Mr. Chapman upon being eligible to choose the title that he had chosen for his paper. He said that there were very few indeed who could look back over two generations of orthodontic work. No one other person had given the Society such thought, care, and industry.

The lesson that he had learnt from the paper was that they must keep their thoughts fluid. There might be in the audience some promising young orthodontist who in the fullness of time would give the Northcroft Memorial Lecture some 50 years hence, and it might well be that he would then take a very poor view of the beliefs to which he devoutly adhered to-day.

It was so easy to crystallize thoughts too soon and to become unreceptive. There was more in heaven and earth than they even dreamt of.

Mr. Chapman, replying to the discussion, said he was grateful for the opportunity to refer to the E.O.S., particularly with regard to its revival. The 1938 meeting was held in London; the 1939 meeting in Germany, so it seemed a dead end had been reached unless this country started the ball rolling again. O. Henry, the treasurer came to see him in the Spring of 1947 with a view to winding up the Socicty. After some discussion, his secretary pointed out what a regrettable step this would be and urged that action be taken to resuscitate the Society, so they decided to call a meeting (a notice was sent to all members), which was held at 26, Portland Place on June 25, 1947; only a few attended—two others I recall were Miss K. C. Smyth and L. Russell Marsh. The outcome was that the first post-war (1939–1945) meeting was held in Brussels in October, 1947, with the late A. E. Rowlett, an international figure in the profession, as president. De Coster had much to do with the organization of the meeting, in collaboration with Watry, chief of the Eastman Institute where the meeting was held.

He would not have it thought that he was ungrateful to Angle—quite the reverse—Angle gave his students a starting point—in fact his ardent desire was that they should all be specialists, and he believed many did specialize when they left the school. Angle may probably be regarded as the indirect founder of the E.O.S. and B.S.S.O. It was chiefly Americans who founded the E.O.S. Perhaps one could trace some connexion between Angle and the S.F.O.D.F. founded in 1921; he believed Quintero's mother was an American and when he returned from St. Louis to Philadelphia after attending the Angle School, he learned that half a dozen Frenchmen had arrived to take the dental course at Pennsylvania and wished for additional instruction in orthodontics; they were unable to go to the Angle School, so he was asked to give them a course; with all the assurance of youth he undertook the task; the six included Georges Villain (president of the 8th International Dental Congress, Paris, 1936), de Nevreze, and Geo. Beltrami, who all became presidents of the S.F.O.D.F.

He had often wondered what the effect would have been if the pronouncements of Lundström and LeRoy Johnson in 1931 had received the same publicity as Angle's dogma that extraction was rarely called for.

Mr. Chapman said that one case which he had shown that evening and had shown previously as a failure, had appeared originally as a success.

With reference to the Californian major, practice in the United states was not quite on the same lines as here. It might be that prosthetics took a large proportion of time there. If the student was not going to practise prosthetics, he could send cases to specialists in that branch. He had gathered from the article in the *American Journal of Orthodontics* that students were taught every other branch of dentistry as in Great Britain.

A RADIOGRAPHIC STUDY OF MOVEMENTS OF THE TONGUE IN SWALLOWING*

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A PRELIMINARY communication upon the general features of the mechanism of swallowing has been given (Ardran and Kemp, 1951). The present paper describes the movements of the tongue in further detail. The material studied comprises cineradiographic examinations of approximately 250 adults of both sexes, under 30 years of age. None of the persons examined had any gross facial or associated dental deformities, or known abnormalities of speech or swallowing; they included persons with full dentition, those who had lost some teeth, and edentulous persons with and without artificial teeth.

The method of examination was cineradiography at 25 frames per second, as previously described. In the last eighteen months X-ray image intensification has been available, thereby making it possible to perform examinations with a considerable reduction in X-ray dosage (Ardran and Wyatt, 1954). The contrast medium has been barium sulphate in large and small amounts, of varying consistency, with and without the addition of food. Anteroposterior, lateral, and oblique projections were taken in the erect, supine, prone, right and left lateral, and inverted positions. The range of examinations performed upon a single individual was varied. Without image intensification, usually not more than four series of cineradiographs were made upon a single individual at one time, but with image intensification in some instances as many as twelve examinations have been made. The usual duration of a single examination was 4 sec., but sometimes a longer exposure was used.

RESULTS

We have learnt to distinguish between the movements necessary for taking food into the mouth, mastication, and the preparation of the bolus, and those necessary for the act of swallowing; these actions may overlap. The movements of the tongue in swallowing will be described first, followed by a description of the different methods of taking food into the mouth.

Swallowing a Small Mouthful.—Each subject was given a dessertspoonful of barium cream and asked to hold it in the mouth in preparation for swallowing.

In the erect position a small fluid bolus rests in a depression upon the upper surface of the forepart of the tongue (*Fig.* 1 A). Spill over the back of the tongue is prevented by arching the tongue behind the bolus and by apposition of the dorsal surface of the tongue to the ventral surface of the soft palate; the apex of the bolus usually projects backwards a little beyond the posterior edge of the hard palate. Spill along the sides of the tongue is prevented by contact between the tongue and the lateral walls and isthmus of the fauces; this contact extends from the pterygo-mandibular ligaments backwards to the posterior pillars. The jaws may be slightly parted or held in the occlusive position. In some individuals the hyoid bone may be slightly elevated.

When swallowing begins the tip of the tongue is thrust forwards against the upper incisor teeth and the posterior surface of the gums, or against the upper alveolus if there are no teeth (*Fig.* 1 E). The tongue is then pressed upwards and forwards against the hard palate, being opposed from before backwards so that the bolus is expressed backwards as if it were tooth-paste being pressed from a tube (*Fig.* 1 E-M). In some subjects the forepart of the tongue rises against the hard palate in the manner depicted in *Fig.* 1 F-J, the

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* This paper is based upon a demonstration of cineradiographie films of deglutition. Certain aspeets of the work have already been published. Further papers relating to the movement of the soft palate and of deglutition in infants are to be published elsewhere.

Given at the meeting held on Deeember 13, 1954.

elevation presenting an almost vertical surface to the bolus. In others, the tongue maintains a convex upper surface, as shown in *Fig.* 3 C, F. As the front of the tongue is raised the arched dorsal surface is lowered, the forepart of the soft palate is depressed and bowed forwards into the mouth cavity, and the seal between the tongue and palate is maintained (*Figs.* 1 D-G, 3 C). As the dorsum of the tongue is further depressed, contact between the soft palate and the tongue is lost from before backwards; the soft palate shortens and thickens and then begins to rise towards the posterior wall of the pharynx, becoming bent in the form of an inverted "V", the axis of the movement being in the general direction of the plane of the fibres of the levator palati muscles. As the soft palate rises, the bolus is often held up momentarily at the level of the anterior pillars of the fauces. The bolus then passes through the anterior pillars and descends upon the sloped dorsal surface of the tongue into the valleculæ. Meanwhile the mesopharynx is narrowed and the opening into the nasopharynx is closed off. When the apex of the bolus reaches the valleculæ it is held up upon the epiglottis, which has been tipped backwards against the posterior pharyngeal wall, but some of the bolus soon spills over the lateral pharyngo-epiglottic folds into the lateral food channels and descends quickly on one or both sides of the larynx into the pharyngo-laryngeal recesses and the œsophagus. The main mass of the bolus is thrust backwards into the pharynx as the superior surface of the tongue is applied, first to the hard palate and then to the soft palate. The slope of the dorsum of the tongue is meanwhile progressively increased and becomes vertical as the last of the bolus is expressed from the mouth; return to the mouth is prevented by the mass of the tongue (*Fig.* 1 K-M).

When swallowing begins, the teeth may be in apposition or slightly parted. As the tongue rises against the palate, the mandible is elevated and the gap between the teeth or gums is progressively reduced while the bolus is expressed from the mouth (*Fig.* 1).

The movements of the hyoid bone in relation to the movements of the tongue and of the bolus have not been fully analysed; the body of the hyoid bone is usually lifted to the level of the lower border of the mandible as the tongue rises in the forepart of the mouth and is drawn forwards as the main mass of the bolus descends through the mesopharynx (*Fig.* 1). In some subjects these movements appear to be combined, the body of the hyoid moving diagonally upwards and forwards. During these movements the hyoid bone is tilted slightly backwards.

In the concluding phase of the second stage of swallowing the tongue arches backwards into the pharynx and the posterior pharyngeal wall is brought forwards to meet it. Apposition takes place from above downwards, with the result that the food is pressed downwards. The larynx is arched backwards and the tongue of the epiglottis is turned downwards (Ardran and Kemp, 1952).

In the anterior projection it may be difficult to visualize the act of swallowing in its entirety on account of the density of the superimposed skull. The bolus passes over the upper surface of the forepart of the tongue in a central furrow. Spill into the cheek cavities is prevented by apposition between the sides of the tongue, the teeth, and the gums. As the tongue rises in the forepart of the mouth the central furrow is obliterated. The bolus is expressed backwards and compressed from below and from the sides; it descends into the pharynx upon the midline of the tongue, and as it reaches the epiglottis it is directed by the glosso-epiglottic fold into the valleculæ.

After the last of the bolus has been displaced from the pharynx there is a pause of about 0·2 sec. while the bolus passes down the œsophagus. Re-inflation of the airways takes place from the larynx below and from the pharynx above; the larynx descends and the tongue is lowered and brought forward. The body of the hyoid bone usually descends diagonally downwards and baekwards to its position of rest, but in some instances it may first move backward and then descend.

Residues.—The first swallow usually leaves a thin coating of barium on the mucous membrane of the mouth. In some subjects the tongue may leave a small residue beneath the

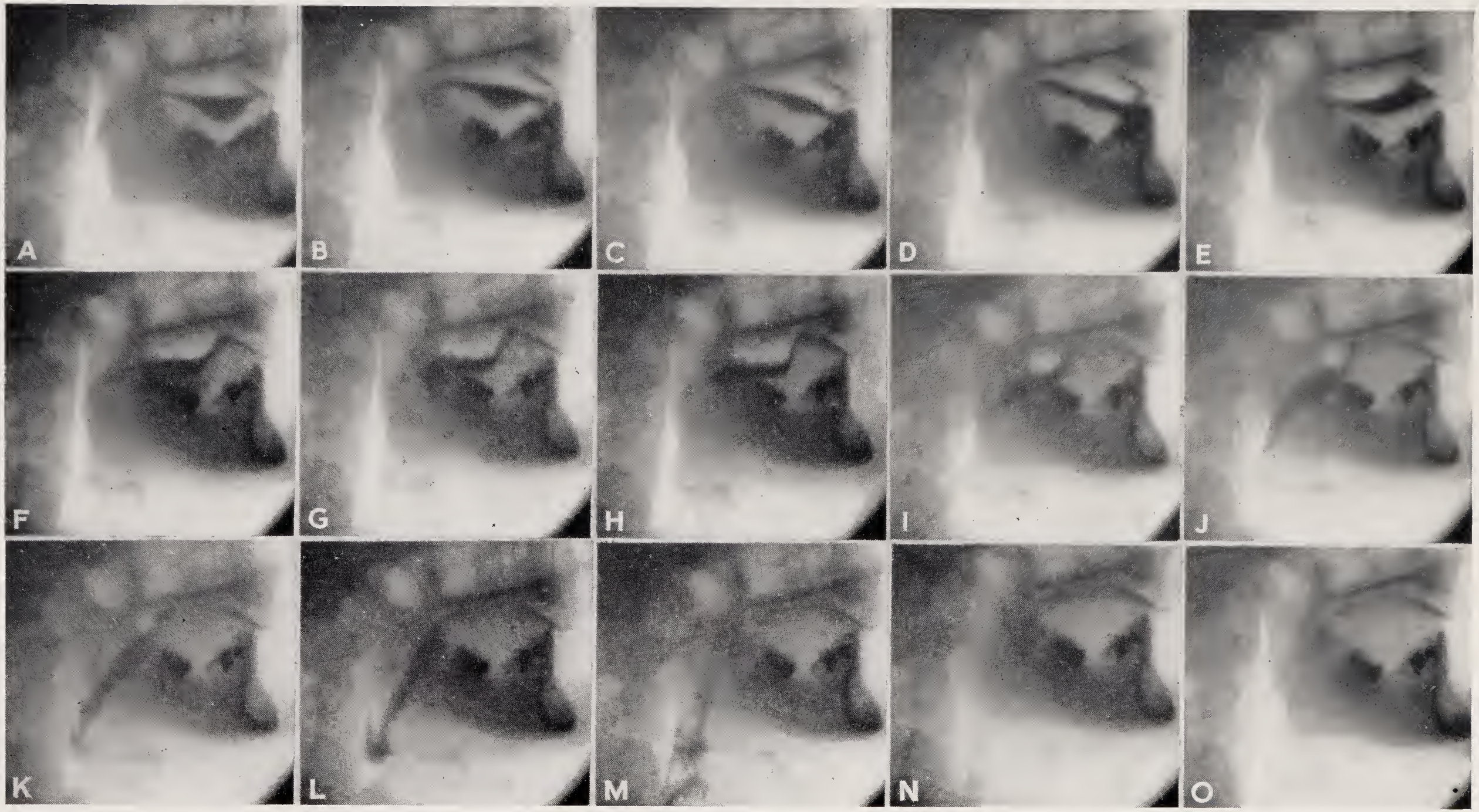

Fig. 1.—Selected from a film taken at 25 frames per second. Swallowing a small bolus. The films of this subject were chosen since the partially edentulous state allows the tongue to be seen clearly.

A, frame 1. A small fluid bolus rests in a hollow on the forepart of the tongue. The air above the fluid level must be considered as part of the bolus and is swallowed as such.

B, frame 2; C, frame 4; D, frame 5. The tip of the tongue is withdrawn to the floor of the mouth; this is frequently, but not invariably, observed prior to the initiation of swallowing.

E, frame 8. Elevation of the tip of the tongue to the upper gum, or incisor teeth when not edentulous.

F, frame 11; G, frame 12; H, frame 15; I, frame 19; J, frame 20. Progressive apposition of the tongue to the hard palate displaces the bolus of air and barium emulsion backwards into the pharynx. Palatoglossal closure is maintained until (I). The hyoid is moved forwards.

K, frame 21; L, frame 22; M, frame 23. Increasing slope of the posterior surface of the tongue.

N, frame 30. Tongue coated with barium: bolus stripped from pharynx.

O, frame 35. Reinflation of the airway. Return of hyoid bone to normal position. Tongue apposed to palate.

Note: The movements of the hyoid bone in this individual are not typical in that elevation is minimal.

dome of the hard palate. There is usually a small residue on the soft palate and tongue in front of the anterior pillars; this is returned to the forepart of the mouth as the pharynx is stripped of its contents. Another small residue is invariably left in the valleculæ. The presence of this and its relation to the laryngeal airway has been previously described (Ardran and Kemp, 1952).

Swallowing a large Mouthful of Fluid.—Each subject was asked to fill the mouth with barium emulsion; 4–5 oz. of barium emulsion may be taken into the mouth cavity, most of it being held in the vestibule (the cavity between the alveolar margins, the cheeks, and the lips). Spill into the pharynx is prevented by the tongue and the soft palate in the manner already described (*Fig.* 2 A).

The position of the tongue and its movements are in part obscured by opaque medium held in the cavities of the cheeks, but if a suitable dilution of barium emulsion is used the main details can be discerned. The contents of the mouth are swallowed as a series of boluses, two, three, or four, of various sizes. Before swallowing is begun, a quantity of barium emulsion collects in the forepart of the mouth in a cavity formed by retraction of the apex of the tongue into the floor of the mouth. When swallowing begins most of the barium contained in this cavity is lifted upon the tongue towards the hard palate; the apex of the tongue is thrust forwards against the back of the upper incisor teeth and the tongue is then progressively apposed to the hard palate from before backwards so that the barium is displaced backwards. When the apex of the bolus reaches the back of the mouth, the soft palate is elevated and the raised dorsal surface of the tongue is lowered; some of the mass of barium carried upon the upper surface of the tongue is then allowed to pass into the mesopharynx (*Fig.* 2 B). But, before all of this barium is cleared from the mouth, the dorsum of the tongue again rises quickly against the front of the soft palate and cuts the barium column in two (*Fig.* 2 C). The quantity of barium allowed to escape into the mesopharynx, the bolus, varies in successive acts of swallowing, from a small fraction to the greater part of that which was carried on the tongue. The bolus passes downwards into the œsophagus whereas the barium left on the tongue is returned to the forepart of the mouth, where it is joined by barium expressed from the vestibule. One swallowing act succeeds another until the mouth is emptied of its contents (*Fig.* 2 D-I).

The passage of each bolus through the pharynx is similar to that observed on swallowing a small mouthful as a single bolus, except in the following respects: With the swallowing of the first bolus the larynx is closed and arched backwards and the epiglottis is turned down. Unless there is a break in the sequence of swallowing movements the larynx remains closed and the epiglottis stays down. During each act of swallowing, so long as the mouth is distended with barium, the arched dorsal surface of the tongue is lowered only enough to allow the bolus to pass through the anterior pillars and then it is quickly raised. Thus the tongue rises to block the exit from the mouth and so prevents the contents from flooding into the pharynx. Backward movement of the tongue is limited; as the posterior wall of the pharynx is unable to move far enough forwards to meet the tongue, clearance of the bolus from the mesopharynx is defective. When the mouth is nearly empty, swallowing of the remaining contents is completed in the manner described for swallowing a small mouthful, the tongue arching backwards to meet the posterior pharyngeal wall so that the pharynx is stripped of its contents.

The mandible is elevated as each bolus is expressed into the pharynx; it is lowered to facilitate emptying of the cheeks. The hyoid bone, having been lifted with the displacement of the first bolus into the pharynx, is lowered while the pharynx is refilling with the second bolus. It is again elevated as the tongue rises to pinch off the second bolus.

Taking Food into the Mouth.—In the adult there are three ways of taking foodstuffs into the mouth:—

1. Suction.
2. By pouring or dropping.
3. By placing the foodstuff into the mouth with the fingers or with an implement such as

a spoon or fork. When an implement is used the foodstuff is usually scraped off it by withdrawal through the apposed teeth and lips.

Sucking through a Straw.—Each subject was asked to suck barium emulsion with a straw from a glass.

The straw is adjusted so that its proximal end is just inside the mouth cavity proper and the distal end beneath the surface of the fluid.

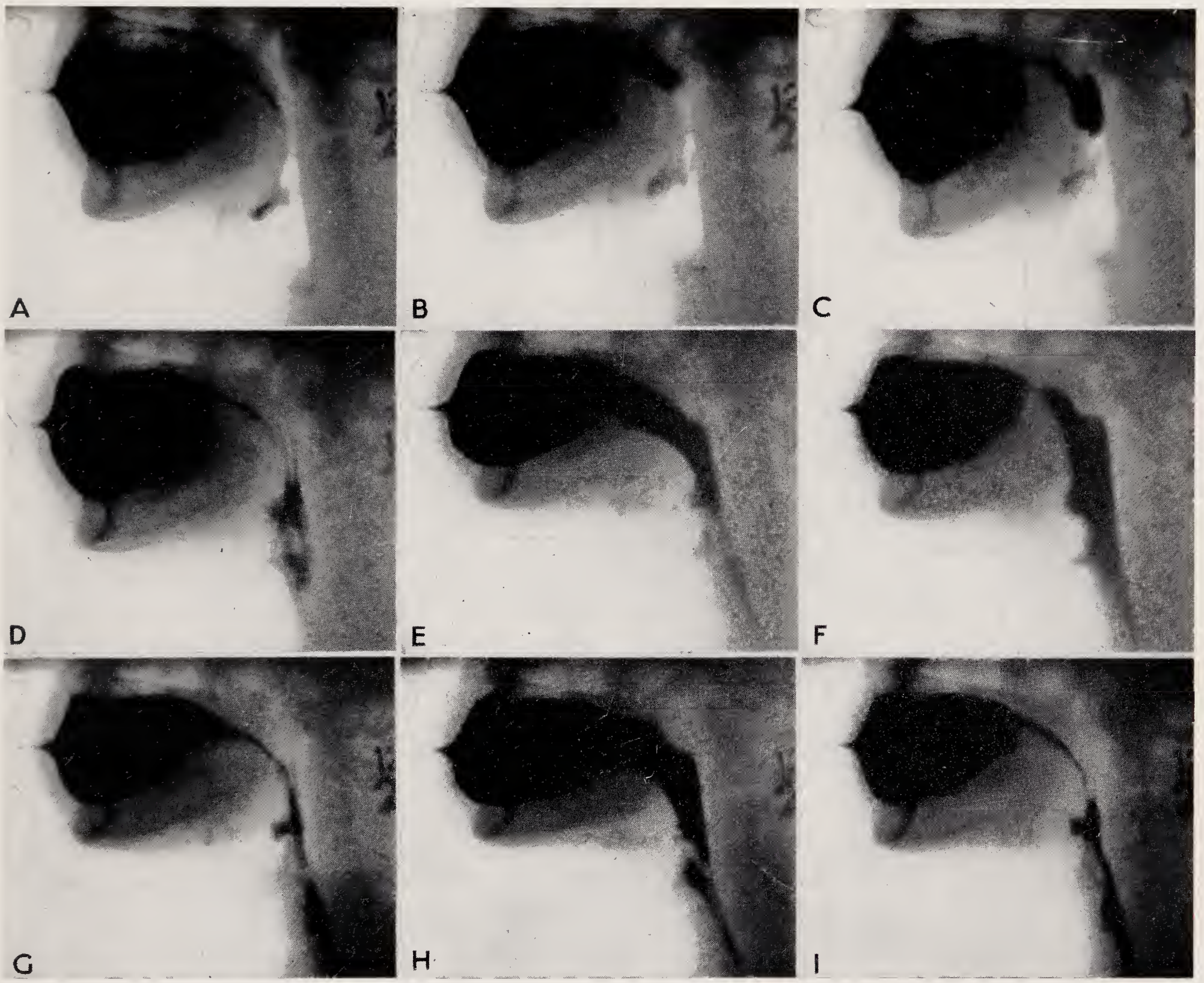

Fig. 2.—A large mouthful of fluid barium emulsion.

A, frame 1. Prior to swallowing. There is a little air beneath the hard palate.
B, frame 4. The palate has been elevated suffieiently to allow the air and a little barium to pass.
C, frame 8. The tongue has elevated against the junetion of the hard and soft palates, eutting off the first bolus.
D, frame 13. Passage of the first bolus through the pharynx.
E, frame 19. The tongue lowered to permit the passage of the seeond bolus.
F, frame 24. The seeond bolus eut off. Compare with C.
G, frame 32. Tongue falling to allow passage of third bolus. Barium in the pharynx remains from the seeond bolus indieating poor stripping action.
H, frame 36. Third bolus entering pharynx.
I, frame 45. Third bolus swallowed. Poor pharyngeal elearanee.

Note: The hyoid bone is elevated and partly obseured by the lower border of the mandible; maximum elevation is assoeiated with elevation of the tongue (C, D, F, and I). Movement of the hyoid forward is minimal. The larynx is elevated and elosed with the passage of the first bolus (D) and remains elosed during the passage of subsequent boluses.

The glass is raised to a comfortable height, the lips are closed around the straw and the head may be slightly bowed forwards. There may be a small quantity of air in the mouth between the forepart of the tongue and the hard palate. The dorsum of the tongue is elevated against the hard and soft palate and the hyoid bone is raised from its position of rest.

When suction begins the tongue is withdrawn from the hard palate from before backwards and fluid is drawn up the straw into the space created, apposition between tongue and soft palate being maintained (*Fig.* 3). When a large quantity of barium emulsion is drawn into the mouth the mandible is lowered, thus creating more space between the superior surface of the tongue and the hard palate, and the forepart of the soft palate is drawn forwards to preserve palatoglossal closure (*Fig.* 3 C); the hyoid bone falls slightly. The barium contained in the mouth is swallowed in the usual manner, the hyoid being elevated and drawn forwards (*Fig.* 3 E-H).

If suction continues, the sequence of movements is repeated again and again. The second bolus begins to enter the mouth as the last of the first bolus passes through the fauces (*Fig.* 3 G). The mode of passage of each successive bolus through the pharynx is similar to that described in swallowing a large mouthful or in drinking. The hyoid bone remains forward and is not moved downwards while the mouth is being re-filled; it is moved backwards as the bolus is being passed from the mouth into the pharynx and is moved forwards again as the bolus passes out of the pharynx.

In some instances suction begins with the soft palate raised, the barium emulsion being drawn into the mouth by expansion of the chest. The amount taken in this manner depends upon the angle at which the head is held and is limited when the fluid reaches a level at which it can pour into the pharynx.

Drinking.—Drinking is usually performed in the following manner: The glass is raised to the mouth, is grasped by the lips, and tilted until the fluid level reaches the lips, the upper lip dipping beneath the fluid. The tongue fills most of the mouth cavity proper, being apposed to the hard palate, the gums, and the teeth.

The first bolus is sucked into the mouth in a manner similar to that described in sucking through a straw. For swallowing to continue, the tilt of the glass must be increased to keep the fluid level at the lips; one bolus succeeds another without reconstitution of the airway until either the vessel is empty or the subject pauses. If the mouth of the vessel is narrow there may be difficulty in keeping the fluid level at the lips because the upper edge of the rim of the vessel comes in contact with the nose, in which case the head is tilted backwards so that the fluid may be poured from the glass into the forepart of the mouth.

Pouring.—The subjects examined were four normal adult males who all believed that they could empty a tankard of ale without a pause. They were given a glass of barium emulsion and asked to drink it quickly.

The glass is raised to the mouth and the first mouthfuls are taken by suction in the manner already described. The subject quickly extends the head and tilts the glass until the contents pour into the mouth.

Three of our subjects held the barium emulsion in the mouth by apposition of the soft palate with the tongue. When the mouth was full its contents were swallowed as a single bolus. Continuity of the flow of barium into the mouth was scarcely interrupted since further barium was taken into the forepart of the mouth as the first bolus was swallowed. The fourth subject swallowed the first bolus in the usual manner, refilling the mouth with barium emulsion as the first bolus was swallowed (*Fig.* 4 A, B). Then the tongue, hyoid bone, and larynx were lowered, apposition between the tongue and soft palate was lost and the barium flooded into the pharynx while still being poured into the mouth (*Fig.* 4 C, D); the tongue was moved forwards as the pharynx was distended and the epiglottis returned to the erect position (*Fig.* 4 E). The tongue was then arched towards the soft palate, momentarily reducing the flow of barium into the pharynx. The tongue was then drawn backwards and downwards and the larynx was moved backwards,

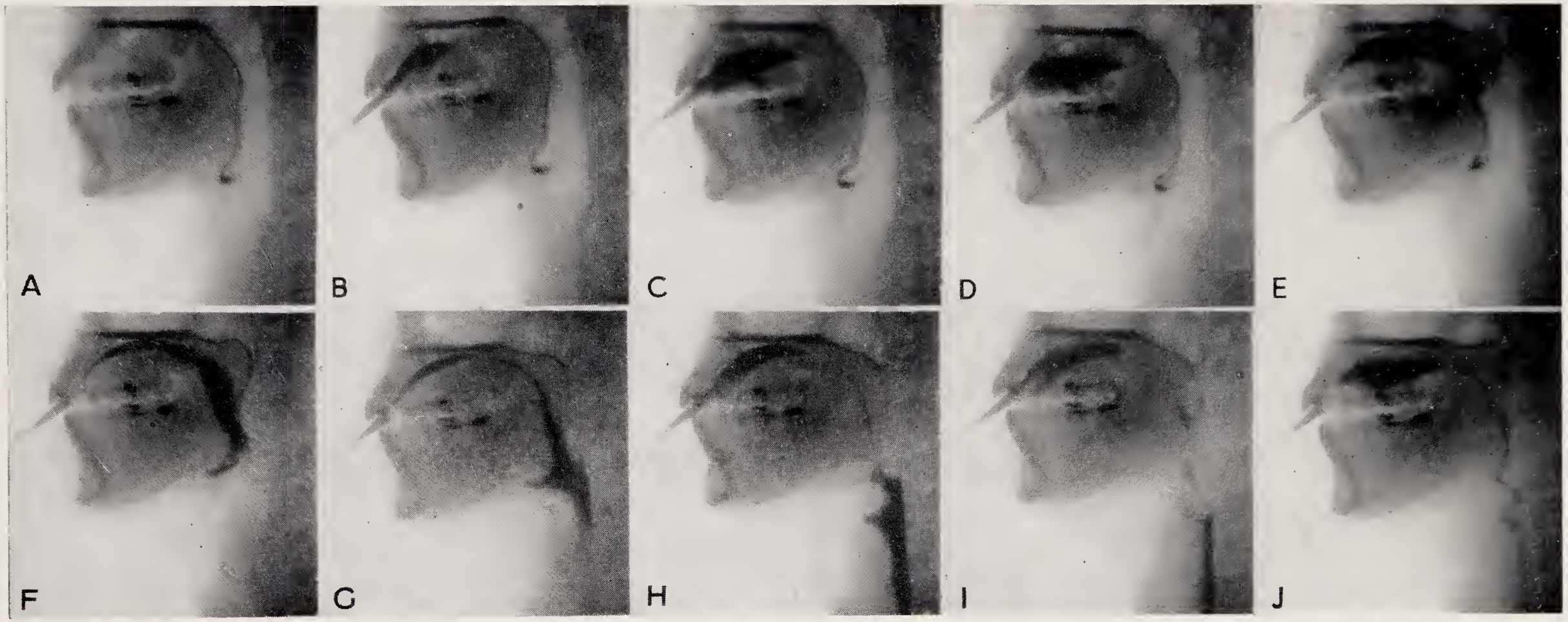

Fig. 3.—Sucking barium emulsion through a straw. Some barium has been run into the nose and outlines the upper surface of the palate.

A, frame 1. Suction beginning; air being drawn up the straw. Palatoglossal seal.

B, frame 28; and C, frame 41. Barium and air on the tongue. Palatoglossal seal maintained. Nasopharyngeal airway open. Suction is created by progressive lowering of the forepart of the tongue from the hard palate.

D, frame 59. Beginning of swallowing. The tip of the tongue raised to the upper incisor teeth.

E, frame 62; and F, frame 65. Squeezing of the bolus backwards: nasopharyngeal closure.

G, frame 67; H, frame 72; and I, frame 75. Entry of second bolus while first bolus is being swallowed.

J, frame 90. Beginning of second swallowing act. Nasopharynx closed (compare with D).

reducing but not obliterating the lumen of the pharynx and assisting the movement of the barium into the œsophagus; the epiglottis moved forwards, the dimensions of the pharynx being again increased (*Fig.* 4 H). The sequence of movements was repeated again and again

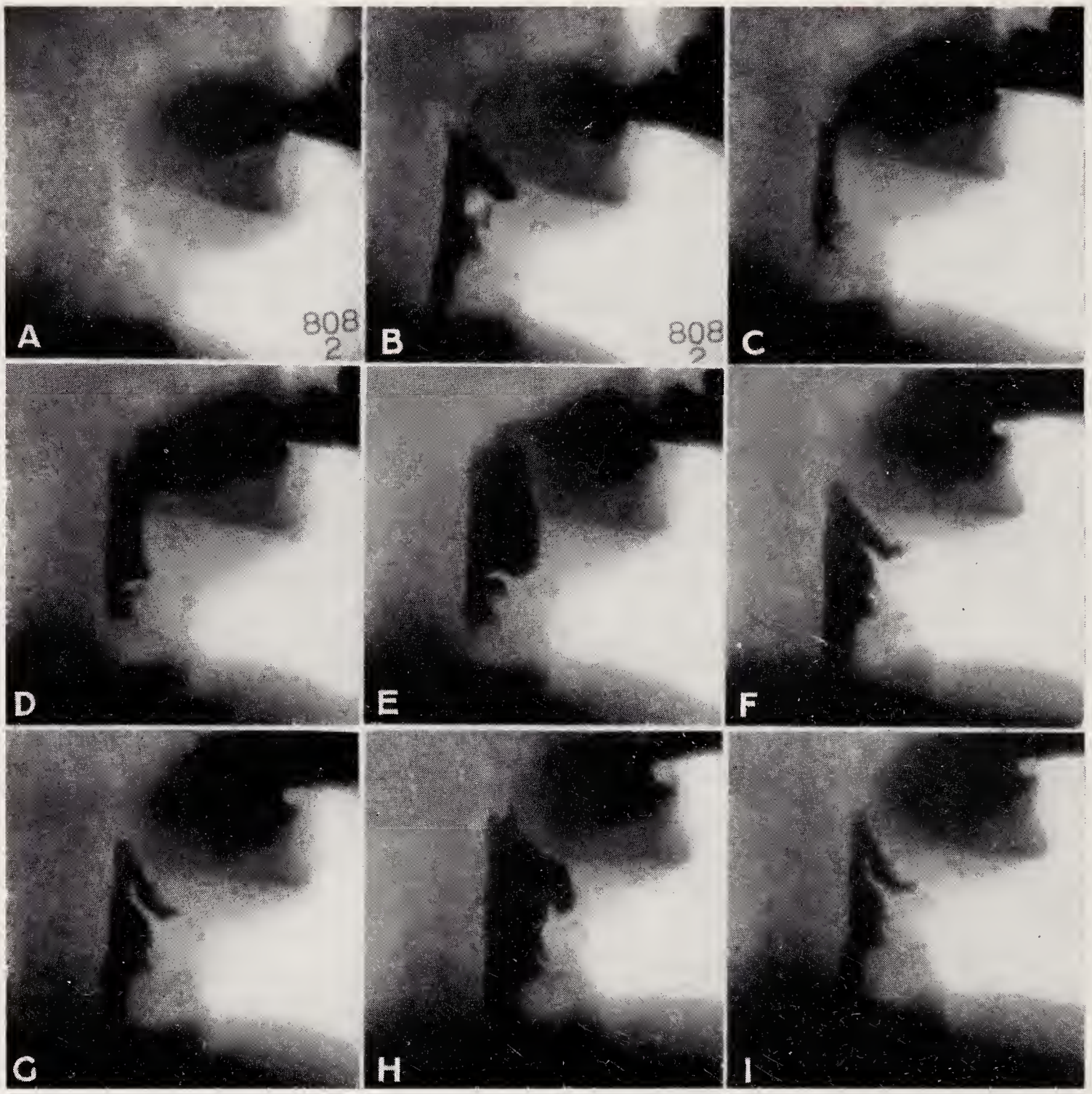

Fig. 4.—Pouring liquid into the mouth.

A, frame 14. The first bolus taken by suction.

B, frame 24. First bolus is cut off and swallowed in the usual manner.

C, frame 33; D, frame 35; E, frame 38. Progressive elevation of the glass, the contents being poured first into the mouth and then into the pharynx. Depression of the hyoid bone and larynx. Elevation of the previously downturned tongue of the epiglottis. The tongue is drawn forwards to increase the capacity of the pharynx.

F, frame 46. Tongue elevated to cut off the second bolus and moved backwards to aid in displacement of the bolus from the pharynx. Tongue of the epiglottis is erect. Trace of barium in laryngeal ventricle and vestibule. The third bolus is being poured into the mouth.

G, frame 48. The tongue and larynx are drawn backwards but pharyngeal clearance is defective.

H, frame 62. Third bolus distending pharynx while the fourth bolus is poured into the mouth. More barium has entered the laryngeal vestibule.

I, frame 68. Tongue and larynx drawn backwards to displace fourth bolus (compare with G) while the fifth fills the mouth. Most of the barium has been expressed from the laryngeal vestibule.

remained erect and there was no significant forward movement of the posterior pharyngeal wall (*Fig.* 4 F, G). The tongue was then drawn downwards and forwards and the larynx was until the glass was emptied, the final bolus being swallowed in the usual manner, the larynx rising and the tongue of the epiglottis being turned down (Ardran and Kemp, 1954).

Taking Paste from a Spoon.—Each subject was given a spoonful of barium paste.

Barium paste may be taken into the mouth by suction, pouring, or dropping, or by scraping the paste from the spoon as it is withdrawn from the mouth through the apposed teeth and lips. The usual method is as follows: The spoon is inserted into the mouth and the lips closed upon it. As the spoon is withdrawn from the mouth its contents are left behind in the forepart of the mouth upon a groove in the tongue. Part, or the whole, is then elevated upon the tongue to the roof of the mouth and swallowed in the manner already described.

Swallowing of Solid Lumps.—Different subjects were given hard chip potatoes, small pieces of apple, and barium-filled capsules, with or without additional barium paste or water. The subjects were asked to position the contents of the mouth in preparation for swallowing.

If the lump is dry many subjects have difficulty in swallowing, but there are some who can swallow small fragments comparatively easily. The method of swallowing is usually similar to that observed on swallowing fluid or paste, but sometimes, especially if the lump is small, the procedure is slightly modified. The soft palate is not elevated towards the posterior pharyngeal wall in the normal manner and is only parted from the tongue as the latter squeezes the bolus backwards.

Individual Variations.—In writing the above account we have endeavoured to distinguish between those movements essential for performing the action under review and other associated movements. The general pattern of each movement is constant but there are many variations in individual behaviour when taking and swallowing food. This is partly due to variations in the size, shape, and consistency of the food, the subject's like or dislike of these substances, the shape of his mouth, and his eating habits. An individual may begin to drink from a cup by sucking with his chest, change to suction with his tongue, and conclude by pouring; the degree to which these three methods are used varies.

Swallowing fluids in the erect position is facilitated by gravity. In other positions the influence of gravity may modify the distribution of fluid boluses at different phases of the act of swallowing and necessitate greater muscular effort, but no fundamental differences in the pattern of the tongue movements in different positions have been observed.

DISCUSSION

The description of swallowing given in most text-books suggests that the bolus is thrown or squirted back into the pharynx. Lerche (1950) quotes Schreiber (1904), who produced a diagram showing the forepart of the tongue turned upwards and backwards to project the bolus into the pharynx. Whillis (1946) observed the behaviour of a man who had a large gap in his cheek. He distinguished two phases in the action of the tongue; in the first the tongue acted as a squirt transferring fluid from the front to the back of the mouth; in the second the mylohyoid muscles came into action and forced the fluid from the oral into the laryngeal part of the pharynx. In swallowing a solid bolus he considered that only the second phase occurred, except when the mouth is cleared of saliva and debris, after the bolus had been swallowed. Schreiber (1904) and Whillis (1946) imply that the bolus is projected into the air-filled pharynx.

Little has been written on this subject by radiologists. The most important contribution was made by MacMillan, who took a series of still radiographs of himself swallowing barium emulsion. Five of this series, arranged to show the movements in correct sequence, form part of a paper by Mosher (1927).

Cineradiographic films, taken with modern X-ray equipment, have made it possible to study the swallowing movements in greater detail. In our preliminary communication we described how the bolus is expressed into the pharynx by a squeezing action of the tongue against the palate, taking place from before backwards (Ardran and Kemp, 1951). A similar description has been given by Rushmer and Hendron (1951) and by Ramsey (1953). The present paper confirms and amplifies these statements.

Barclay (1936) claimed that the pharynx was always closed a fraction of a second before

the swallow and that the movement of the bolus through the pharynx was due to suction created by reopening the pharynx with the nasal and laryngeal passages closed. Barclay's views have been strongly refuted by Negus (1948), who measured positive pressures in the pharynx during the passage of a bolus in a patient who had a lateral pharyngeal stoma, and by Rushmer and Hendron (1951), who recorded positive pressures in the pharynx during the passage of the bolus in normal subjects. Our cineradiographic records lend no support to Barclay's statement that a negative pressure plays a significant part in the swallowing of a liquid or solid bolus. In most normal subjects the bolus descends into the pharynx while it still contains air and while the larynx is still open. It has also been observed that the transit of the bolus through the pharynx may occur quite normally in subjects in whom nasopharyngeal closure is defective. The expression of the bolus from the mouth by apposition of the tongue against the palate is normally continued in the pharynx by apposition of the tongue and the pharyngeal constrictors; the wave of contraction of the pharyngeal constrictors takes place from above downwards. It is clear how Barclay came to put forward his theory. He examined his subjects by fluoroscopy while they were drinking and observed the obliteration of the pharyngeal lumen as each bolus was stripped from the pharynx. From this observation he concluded that for swallowing it was necessary to obliterate the pharyngeal lumen so that by its reopening the bolus would be sucked in. He failed to observe that this phenomenon did not occur when swallowing a single bolus. Air is sucked into the pharynx, in the manner described by Barclay, upon the reinflation of the airways, proving that at this phase there is negative pressure in the pharynx.

In the normal individual the bulk of the bolus is normally swallowed in the midline over the dorsum of the tongue. Spill along the sides of the tongue may be seen on pouring fluid into the mouth or throat or in individuals who have some abnormality. Whillis's patient (1946) was able to pass his food entirely on the side of the tongue, opposite to the operative defect. We have examined three similar patients; they all tended to displace the bolus in the same manner. A similar pattern of movements may be seen in patients with a cleft-palate defect who sometimes pass the bolus on both sides of the tongue and in some patients with neuromuscular disorders (Ardran and Kemp, to be published).

Many writers fail to distinguish between the movements of swallowing and those necessary for taking food into the mouth. Auerbach (1888) clearly recognized the importance of suction in drinking, and that there were two methods of suction, with the tongue and with the chest. He measured the negative pressures created. Rushmer and Hendron (1951) give a clear account of the action of the tongue in sucking fluid into the mouth. A clinical distinction between suction and suckling has been given by Gwynne-Evans (1951).

SUMMARY

A description is given of the action of the tongue in taking food into the mouth and in deglutition, based on a study of cineradiographic films taken of 250 normal young adults.

Acknowledgements.—We are indebted to the numerous volunteers who have consented to be examined; and to Professor T. Pomfret Kilner, Mr. Ronald Macbeth, Mr. Gavin Livingstone, and other clinical colleagues for permission to examine a number of their patients.

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DISCUSSION

Mr. E. Gwynne-Evans, opening the discussion, said that about two years ago he and Professor Whillis paid a visit to Oxford, where they spent a happy day with Ardran and Kemp viewing many cineradiographic records of feeding and swallowing behaviour in slow motion. Their technique of cine-analysis had been brought to a high and finite level. He said "finite" because movements of muscles and structures could be analysed frame by frame and there was no doubt of what was seen. The interpretation might be open to discussion, however, for only through viewing these films over and over again could they say which movements were important and which irrelevant, which could be ignored and which were of significance. In time, typical and atypical patterns of movement became familiar. The danger lay in seeing movements not as they were, but as one expected them to be.

For instance, in suckling behaviour they would adduce from clinical observations and from the studies of Negus that milk passed in an intermittent stream on either side of the upraised margins of the epiglottis, without closure of the glottis or elevation of the soft palate. A film of suckling behaviour taken by Russell Reynolds a few years ago showed the soft palate being actively tensed against the tongue, and Mr. Gwynne-Evans then had no doubt of the open glottis and the continuation of breathing. Films taken by Ardran and Kemp, however, had revealed the unexpected, in that milk might accumulate in the mouth to form a liquid bolus, which was then swallowed with glottic closure and elevation of the soft palate. It might well be that both methods of transferring milk from the mouth to the pharynx existed in life.

Professor Last, in a paper to the Royal Society of Medicine, had already referred to the danger of speculative reasoning and deduction of armchair anatomy. Even clinical observation was beset with dangers if that observation were made in unnatural circumstances. For instance, Ardran and Kemp had pointed out in their writings that laryngoscopy, even with the laryngeal mirror, might give a false interpretation of the movements of the vocal cords in respiration, because the mouth was widely open and the tongue was held forward. To his mind, therefore, cineradiography of orofacial, pharyngeal, and laryngeal movements in breathing, feeding, and swallowing behaviour was of the greatest value, not so much because such movements were normally hidden from view or were too rapid to discern even when they could be viewed as the result of operative measures which included removal of the cheek and part of the jaw or maxilla, but because such movements could be recorded in their natural environment.

Their interest was in the action of the tongue, facial muscles, and lips in the control and transportation of the liquid or semi-soft bolus. Observations on the behaviour of the orofacial muscles from infancy to adolescence had been recorded on slow motion cine-film by Rix, Ballard, Tulley, Mr. Gwynne-Evans himself, and others; Tulley was recording patterns of action potentials from the contractions of the muscles by means of the electromyograph: Anderson had recorded electrically pressure forces between the occluding teeth in chewing and in swallowing; this evening, they were benefiting from the experience of cineradiography.

Much research had been conducted into the neurophysiology of muscle patterning, into the evolutionary history of feeding behaviour, and into the comparative anatomy of the masticatory mechanism. Only when all aspects of the problems before them had been correlated would the truth be known.

He was rapidly becoming an old "boffin", and old boffins were inclined to reminisce. His duty was to open the discussion and he would refrain from saying more. He congratulated the authors on their patience and on the meticulous care with which they had made their records. He ended with a question which he realized might be difficult, if not impossible, to answer at this stage of their investigations. Had any variation been noticed in the direction of the upward and forward thrust of the foremost part of the tongue when swallowing commenced? Might the tongue be pressed against the lingual surface of the upper incisor teeth or might it even pass between the upper and lower incisor teeth in some cases? Was the pressure of the tongue always due to an act of the tongue itself or might it be due to the contraction of the mylohyoid and be in the nature of a spread rather than an active thrust?

Mr. Rix said he had seen stills from the films before. They were fascinating, and the authors were to be congratulated on their superb technique. Was the viscosity of the barium the same throughout all the illustrations or was it, in some of the examples, given in a more viscous state than could be described as "fluid"? Had the authors any films of the swallowing of people with obvious speech defects? Had they noticed any peculiarities in the behaviour of the tongue in swallowing with such people? As orthodontists, they were apt to be frightened of speech defects.

The illustrations seemed to show beyond doubt that in bottle feeding the gum pads of the infant were not brought together. There seemed to be no apposition of gum pads at any time.

Miss Clinch said that it seemed from many of the films that the teeth were not brought into apposition when swallowing. Was this so? And was pressure exerted by the cheeks during swallowing?

Mr. Hovell asked the authors whether they had made any observations of the part played by swallowing in post-nasal drainage. In relation to atypical swallowing actions, had they noticed any association with inadequate post-nasal drainage and nasal pharyngeal closure? The point made by Mr. Rix about lack of apposition of the gum pads was important. Had the authors seen any evidence of the tongue being protruded between the lower jaw and the base of the nipple during the suckling action? Without intending to be irreverent, he wanted to know whether the authors had taken any photographs of patients swallowing while standing on their heads.

Dr. Kemp, in reply, said they had taken photographs of people lying on their faces, on their backs, on the right and left laterals, and upside down.

The question on post-nasal drainage was extremely interesting. They had gone into it in connexion with a paper they were preparing on the palate, but they had been disappointed with their experiments. They had been interested in the clearance of the mucus and the barium from the back of the nose; gravity helped, of course, but it was remarkable how inefficient swallowing was from the point of view of clearing that material away. He referred to the Rosenmuller fossa and said the clearance was very defective.

He agreed that in many of the films the teeth were not tightly in apposition, but the combined action of teeth,

cheek, and tongue was at least enough to stop the barium from being squirted into the cheek cavity during the swallowing. They had not considered the problem at all fully.

They had noticed that the gum pads were not in apposition, but they had only just begun the examination of very young children and would hesitate to go into the question in detail at present.

The only speech defect in children so far explored was defective nasopharyngeal closure—speech with a nasal escape, such as they saw in relation to the submucous cleft of the palate and various cleft-palate abnormalities. They had investigated the act of swallowing in those people. as well as the action of closure of the soft palate, and they had found that swallowing in such people was frequently abnormal.

Barium had been used when mixed with all kinds of foodstuffs, but the viscosity of the material used had not been measured. Barium milk, barium porridge, barium mixed with potato mash, and all kinds of thickness of barium itself had been used, as well as barium mixed with solid foodstuffs. They had not gone into the matter to great depth, beyond establishing the fact that viscosity was a factor in swallowing. Gravity was an important influence in swallowing and the viscosity of the material being swallowed was very important. The more gluey the material was, the more it stuck.

Mr. Gwynne-Evans had asked about abnormal swallowing patterns, but beyond the fact that he was quite certain that they occurred, Dr. Kemp said he could give no information as he had not yet gone into the subject. The authors had read with interest the papers on these activities which Mr. Gwynne-Evans had mentioned, but had not so far taken up the work. They recognized their limitations; they had to deal with one small part of the work at a time.

Mr. Gwynne-Evans had asked whether the tongue apposition to the soft palate was active or passive. The authors acknowledged that they did not know. The tongue was apposed to the hard palate from before backwards. The tongue was spread—there was no question about that. How did it spread? By something intrinsic in the tongue or by the mylohyoid muscles? The authors had done no work to supply the answer. They knew that the tongue went between the teeth in certain acts of swallowing, but they had not deliberately studied the normal swallowing actions of children as yet. That was work still to be done.

REPORTS OF MEETINGS

ORDINARY MEETING, January 11

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, January 11, 1954, at 7.30 p.m. At the beginning of the meeting the Chair was taken by Mr. Harold Chapman (Vice-President).

The Chairman said the members would remember that at the last meeting Mr. W. Trevor Johnson had been unable, through illness, to attend for his induction as President. On the present occasion Mr. Pilbeam, the Immediate Past President, was unable to attend, also owing to indisposition, and it was for that reason that he, as Vice-President, was occupying the Chair.

The Minutes of the last meeting, held on December 14, 1953, were read, confirmed, and signed.

The Chairman, in inducting Mr. W. Trevor Johnson into the Presidential Chair and investing him with the President's Badge of Office, expressed the hope that he would have a very happy year as President of the Society.

The President said that he had been a member of the Society for a good many years and he thought it was for that rather than any other reason that he had been elected to the high office of President. He would do his best to carry out his Presidential duties to the satisfaction of the members.

The President then welcomed the visitors who were present and expressed the hope that they would take part in the discussions.

The following candidates for membership of the Society, who had been approved by the Council, were elected *en bloc* by show of hands:—

Miss G. Stewart, L.D.S., 15, Dollis Hill Lane, London, N.W.2;

Mr. R. G. Kettle, L.D.S. R.C.S. (Eng.), 43, High Street, Wimbledon Common, London, S.W.19;

Mr. R. W. Willcocks, B.D.S. (Lond.), 67, Huntingdon Road, Finchley, London, N.2.

The following short paper was then read by Mr. W. A. Nicol:—

"*The Morphology of the Lips in Relation to the Incisor Teeth: A Preliminary Report*".

The President then delivered the Presidential Address:—

"*The Orthodontic Problem*".

The vote of thanks was accorded with acclamation.

On the motion of the President, a vote of thanks was accorded to Mr. Nicol for his interesting and valuable paper, and the meeting then terminated.

ORDINARY MEETING, February 8

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, February 8, 1954, at 7.30 p.m. The President, Mr. W. Trevor Johnson, occupied the Chair.

The Minutes of the previous meeting, held on Monday, January 11, 1954, were read, confirmed, and signed.

The President welcomed the visitors present and invited them to take part in the discussion on the papers which were to be read.

The following recently elected members were introduced to the President and signed the Obligation Book: Mr. R. G. Kettle and Mr. R. W. Willcocks.

The following candidates for membership of the Society, who had been approved by the Council, were elected *en bloc* by show of hands:—

Miss F. L. Franks, L.D.S. R.C.S. (Eng.), Dental Clinic, Sawclose, Bath, Somerset;

Mr. W. Finkel, L.D.S. R.C.S. (Eng.), 561, Green Lanes, Palmers Green, London, N.13;

Mr. W. Frankland, B.D.S. (Manch.), Birmingham Dental Hospital, Birmingham, 3;

Mr. T. Smith, B.D.S. (U. Lond.), 103, Jerningham Road, London, S.E.14;

Mr. N. K. Thorn, L.D.S. R.C.S. (Eng.), Foxgloves, Downs Road, Northfleet, Kent;

Mr. E. A. Westbrook, L.D.S. R.C.S. (Eng.), 79, Harley Street, London, W.1.

The PRESIDENT, in introducing Mr. W. G. Holdsworth, who was to read a paper on "*Surgery in Cleft Lip and Palate*", in Part I of a symposium on the treatment of cleft palate, said that Mr. Holdsworth was Consultant in Cleft Palate Surgery at the Plastic and Jaw Unit, Basingstoke. The subject with which his paper dealt was one that presented great difficulty to orthodontists, and no doubt they would obtain a great deal of valuable information from the paper.

Mr. W. G. HOLDSWORTH then read his paper on:—

"*Surgery in Cleft Lip and Palate*".

At the conclusion of this paper the contribution forming Part II of the symposium was given by Mr. M. A. KETTLE on:—

"*The Development of the Orthodontic Problem*".

The PRESIDENT, in proposing a vote of thanks to Mr. Holdsworth and Mr. Kettle, and to all those who had taken part in the discussion said that both the papers and the discussion had been of a very high standard and would make an excellent foundation for the subject which was to be dealt with at the next meeting, namely, prosthetics in cases of cleft palate.

The vote of thanks was accorded with acclamation, and the meeting then terminated.

ORDINARY MEETING, March 8

AN ORDINARY MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, March 8, 1954, at 7.30 p.m. The President, Mr. W. Trevor Johnson, occupied the Chair.

The Minutes of the Ordinary Meeting held on February 8, 1954, were read, confirmed, and signed.

The PRESIDENT welcomed the visitors who were present and invited them to take part in the discussion on the papers which were to be read at the meeting.

Mr. W. Finkel, a recently elected member, signed the Obligation Book and was introduced to the President, who formally admitted him to membership of the Society.

The following candidates for membership of the Society, approved by the Council, were elected *en bloc* by show of hands:—

Miss E. M. Myers, L.D.S., National Provincial Bank, Barnet, Herts;

Mr. D. S. Ellis, B.D.S., 38, Trinity College, Dublin;

Mr. D. O. Mole, L.D.S., 7, Stream Park, Kingswinford, Near Brierley Hill, Staffs;

Mr. D. J. Timms, L.D.S., Dental Department, University College Hospital, Great Portland Street, W.1.

In the Symposium on the treatment of cleft palate, the following papers were then read:—

Mr. M. A. KETTLE on: "*The Orthodontic Treatment of Dental Deformities due to Cleft Lip and Palate*".

Mr. N. L. ROWE on: "*Secondary Surgical Procedures for the Correction of Deformity in the Cleft Lip and Palate Patient*".

On the motion of the President, a vote of thanks was accorded to the authors of the papers and to all those who had taken part in the discussion, and the meeting then terminated.

DEMONSTRATION MEETING, May 10

A DEMONSTRATION MEETING of the Society was held at Manson House, 26, Portland Place, London, W. 1, on Monday, May 10, 1954, at 7.30 p.m.

The Minutes of the previous Ordinary Meeting, held on March 8, 1954, were read, confirmed, and signed.

The following candidates for election were admitted *en bloc*:—

Mr. E. J. Artes, B.D.S. (Lond.), 109, Hermon Hill, South Woodford, E. 18;

Mr. M. F. Ashby, L.D.S. (Eng.), 50, Cameron Road, Seven Kings, Essex;

Mr. R. F. Hathaway, L.D.S. (Eng.), Greenway, Timberlog Lane, Woodlands Avenue, Basildon, Sussex;

Mr. N. H. Reeves, B.D.S. (Lond.), 110 Wakehurst Road, S.W. 11.

Corresponding Member:

Mr. Leif Ljungdahl, 25 Stortorget, Malmö, Sweden.

The following Demonstrations were then given:—

Mr. C. P. Adams: "*Variations of the Modified Arrowhead Clasp*".

Mr. A. C. Campbell: "*Some Removable Lower Appliances*".

Mr. G. C. Dickson: "*A Portable Craniostat for use with Normal Dental Surgery Equipment*".

Dr. F. L. Ingram: "*Tomography in Cleft Palate*".

Mr. S. Granger McCallin: "*Orthodontic Traction with Removable Appliances*".

Mr. J. S. Rose: "*Orthodontic Teaching Models*".

Mr. J. W. Softley: "*A Method of Space Closure*".

Mr. D. P. Walther: "*Appliances used in the Orthodontic Treatment of Cleft-Palate Cases*".

ORDINARY MEETING, October 11

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, October 11, 1954, at 7.30 p.m. In the absence of the President (Mr. W. Trevor Johnson), the Chair was taken by Mr. J. F. Pilbeam, the Immediate Past President.

The Minutes of the Demonstration Meeting held on May 10, 1954, were read, confirmed, and signed.

The Secretary (Mr. Howell Richards) reminded the members that the reports of the Society's meetings were now published in *The Dental Practitioner* and said that it would help the Society financially if the members became subscribers to that journal. At the moment the number of members subscribing regularly, by subscription form, was too small to enable the Society to receive any financial benefit.

The President of the French Orthodontic Society, Dr. Merle Beral, had written to say that that Society would welcome non-members at its next Congress, which was to be held at Albi, Tarn, France, from May 19 to May 22, 1955. Members of the profession who would like to receive notices of the Congress when they were issued should apply direct to Dr. Merle Beral.

The Chairman welcomed the visitors who were present and said that they would be considered as members of the Society for the meeting. He would be glad if they would take part in the discussion on the paper to be read if they wished so to do.

The following recently elected members signed the Obligation Book and were introduced to the Chairman, who admitted them to the Society: Mr. E. J. Artes, Mr. M. F. Ashby, Mr. J. Hopper, and Mr. N. H. Reeves.

The following candidates for membership of the Society, who had been approved by the Council, were elected *en bloc* by show of hands:—

Mr. R. Baines, L.D.S., 4, Queen Anne Street, W.1;

Mr. H. Dallas, L.D.S., 9, Windsor Park, Bangor, Co. Down, N. Ireland;

Mr. E. Miller, L.D.S. R.C.S. (Edin.), 142, Eccles New Road, Salford 5, Lancashire;

Mr. A. F. D. Shapland, L.D.S. R.C.S. (Eng.), Burnside, Topsham Road, Countess Weir, Exeter, Devonshire;

Mr. C. Sumsawaste, L.D.S. R.C.S. (Eng.), 425, Green Lane, Ilford, Essex.

Dr. John Campbell, Ph.D., D.D.O., L.D.S., then read the following paper:—

"*Mandibular Displacement*".

The Chairman, in proposing a vote of thanks to Dr. Campbell and to Mr. Hopper and all those who had taken part in the discussion, said that a knowledge of mandibular displacement was of great value to orthodontists, as more of the cases of facial pain were being referred to them, especially in hospital practice.

The vote of thanks was accorded with applause, and the meeting then terminated.

ORDINARY MEETING, November 8

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, November 8, 1954, at 7.30 p.m. The President, Mr. W. Trevor Johnson, occupied the Chair.

The Minutes of the Ordinary Meeting held on October 11, 1954, were read, confirmed, and signed.

The Secretary (Mr. Howell Richards) announced the receipt of a telegram from Professor Selmer-Olsen wishing the Society, and Mr. Chapman in particular, every success for the meeting.

The President welcomed the visitors who were present and said he would be glad if they would regard themselves as members of the Society for the evening and take part in the discussion if they wished to do so.

The following recently elected members signed the Obligation Book and were introduced to the President, who admitted them to the Society: Mrs. Capleton, Miss Myers, and Mr. R. Baines.

The following candidates for membership of the Society, who had been approved by the Council, were elected *en bloc* by show of hands:—

Candidates for election:—

Mr. W. E. Bernard, L.D.S. R.C.S. (Eng.), 8, Windsor Place, Liskeard, Cornwall;

Mr. D. R. Clifton, L.D.S. R.C.S. (Eng.), 27, Watling Street, St. Albans, Herts;

Mr. W. J. Donaldson, L.D.S., R.F.P.S. (Glas.), Cestria, Ledborough Lane, Beaconsfield, Bucks;

Mr. J. F. Reading, B.D.S. (Sydney), F.D.S., R.C.S. (Eng.), Eastman Dental Hospital, Grays Inn Road, W.C.1;

Mr. J. K. Wilkie, B.D.S. (Durham), Lansdowne House, Bath Road, Taplow, Maidenhead.

Corresponding Members:—

Mr. K. A. E. Gränse, L.D.S. (Stockholm), Mariedalsvagen 25, Malmö, Sweden;

Mr. E. T. Lang, B.D.S. (N.Z.), D.D.O. (Glas.), Broome's Building, Devon Street, New Plymouth, New Zealand.

Eighth Northcroft Memorial Lecture

The President said that, before calling upon Mr. Harold Chapman to deliver the Eighth Northcroft Memorial Lecture, he wished to say for the benefit of any new members who might be present that among the conditions laid down at the foundation of the Lectureship there was one that decreed that each year it should be awarded to a selected member or non-member known to have material of high merit to add to their proceedings. The distinction had been awarded to Mr. Chapman this year, and he was sure that Mr. Chapman was particularly able to speak on the selected subject.

He felt that it was not out of place for him once again to recall the vast amount of work which Mr. Chapman had done for the Society. Within his own time, some 35 years, he had found Mr. Chapman continuously in office as President, Secretary, Treasurer, or some other post, and he was still a very active Vice-President and never missed a Council meeting. Mr. Chapman's contributions to the *Transactions* had been very many and of high order and they were well known at home and abroad. Many theories which Mr. Chapman had expounded some 25 years ago were re-read with advantage to-day. Mr. Chapman and Dr. Northcroft were lifelong friends and were founder members of the Society when it was formed in 1907.

All those things combined to make it a very great pleasure and privilege to him to ask Mr. Chapman to deliver the Eighth Northcroft Memorial Lecture.

Mr. Harold Chapman then read his paper on :—

"*Orthodontics: Fifty Years in Retrospect*".

The President proposed a vote of thanks to Mr. Chapman and those who had taken part in the discussion.

He said that in introducing Mr. Chapman he had said that he thought he was well able to speak on the subject, but he had not then realized that it would be such a very great paper. It was a very great contribution to the *Transactions*.

The vote of thanks was accorded with applause, and the meeting then terminated.

ANNUAL GENERAL MEETING,
December 13

The Annual General Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, December 13, 1954, at 7 p.m. The President Mr. W. Trevor Johnson, occupied the Chair.

The Minutes of the previous meeting were read and confirmed.

The PRESIDENT declared that, there being no counter-nominations, the officers and the Council were elected in accordance with the names set out on the Agenda.

Messrs. S. B. Newton and T. L. Winn were elected as auditors.

The HONORARY TREASURER (Mr. J. S. Beresford) presented his report, which was adopted. He reported an excess of income over expenditure for the year, reflecting the sound state in which the previous Honorary Secretary had left the Society's affairs. Expenses increased almost yearly, but lantern and film expenses had been reduced because of the generosity of the honorary editor, who had acted as unpaid lantern operator.

The estimated reserve for the 1954 transactions might be less accurate than in previous years because the necessary figures for an accurate estimate were not available.

Mr. KETTLE asked whether the hire of the hall included the heating of the hall. Despite the fact that it was the hall of "The Royal Society for Tropical Medicine", members shivered with cold during the meetings.

The SECRETARY reported that the point had been discussed with the hall managers for some time and a number of not very satisfactory reasons had been given for the temperature in the hall. In spite of many protests, they had been unable to get the hall heated. Although the heaters were working, they did not seem to have very much effect.

The SECRETARY reported that in the 12 months from December, 1953, to November, 1954, seven meetings had been held with an average attendance of 106 members and visitors per meeting. This was the first time in the Society's history that the average attendance had exceeded 100 and it was an indication of the Society's increasing strength —and also of the Secretary's persistence in requesting everyone to sign the attendance book!

During the year, 30 new members had been elected and 27 of them had become full members. There had been 4 deaths and 6 resignations. The membership, on January 1, 1955, was expected to be 393.

The question of country meetings had occupied a great deal of the Council's deliberations, and it had been decided to hold the May meeting in Sheffield, where the meeting would take the form of a two-day conference. A questionnaire had been circulated; 98 replies were received, of which 57 were in favour and 40 against, with one apparently both for and against. This response had been a great improvement on that to the previous request, which produced only 5 replies.

The Secretary accepted no responsibility for the failure of members to read notices on the Agenda. To those who complained that they were not reminded about subscriptions, he pointed out that reminders were included in the agenda from December to March each year.

In the past, the Honorary Editor had had difficulty with the publishers and the Secretary had had difficulty with both the printers and the publishers. This year changes had been made in the publishing arrangements and it was hoped that the problems would become less acute. A more favourable atmosphere surrounded the dealings with Messrs. John Wright & Sons Ltd.

He thanked the Council for their forbearance over the last six years and placed the secretaryship in the capable hands of Mr. Leech.

The Secretary's Report was adopted.

The Report of the Librarian (Mr. A. G. TAYLOR) was adopted. After recording new additions to the Library, Mr. Taylor said the number of items borrowed from the Library this year had declined sharply to less than half the record number of 1953.

The Library was built on the foundation of years of discrimination in the acquisition of orthodontic text-books. It subscribed to the *American Journal of Orthodontics* and the *Angle Orthodontist.*

Sales of copies of past *Transactions* by the Library had broken records and the fear that it might run out of print of certain years' *Transactions* had been realized. The years

1927, 1940–41, 1942–43, 1947, 1948, and 1949 were all out of print and there was already a substantial waiting list for the odd copies which turned up from time to time.

As so many copies of past *Transactions* were sold to dental schools in this country and abroad, he appealed to any members who could spare their volumes for the 40's to let him have them, for the benefit of the Society and in all probability for the dental schools.

He had received a letter from the Librarian of the Norwegian State Dental School asking for copies of the *Transactions* from 1940–48, and, unless members sent in their copies, he would be able to let the Norwegian School have only the copies for the years 1944–45–46.

The Honorary Editor (Mr. BALLARD) presented his Report, which was adopted.

He said that relations with the new publishers of the Proceedings had been very satisfactory and members would agree that the publication of the Papers was technically of a very high standard. The illustrations, in particular, were very good. Any delay in the publication of the papers had not been due to Messrs. Wright, but to the failure of the readers to return the various papers in time. The discussions were being printed in précis form, following the papers, in *The Dental Practitioner*.

The 1953 Transactions were in page proof form and should be sent out early in the New Year. Publication of these *Transactions* was in the hands of the previous year's publishers, however.

He was glad to report that the Northcroft Memorial Lecture by Professor Friel had been printed in the *American Journal of Orthodontics* and would be produced in last year's *Transactions*. For this they must thank the editor and the publishers of the *American Journal of Orthodontics*.

The Report by the Curator (Mr. W. J. TULLEY) was read by the Secretary and adopted.

It had been an uneventful year for the museum. He drew attention to the type of material in which they were interested; first, serial models of developing occlusions; secondly, models and possibly photographs and cephalometric tracings of treated cases; and, thirdly, pathological conditions of jaws and teeth which affect the occlusions.

The PRESIDENT thanked the officers for their excellent Reports.

The meeting was then thrown open to visitors, who were welcomed by the President.

The PRESIDENT, in introducing the authors of the paper, said they were newcomers to the Society. Dr. Ardran was radiologist to the Nuffield Institute of Medical Research, Oxford, and Dr. Kemp was radiologist to the Radcliffe Infirmary. Both had done much research work on the physiology of swallowing.

Dr. G. M. ARDRAN and Dr. F. H. KEMP then presented the following paper:—
"*Some Radiological Observations on the Mouth and Pharynx in Action*".

The PRESIDENT moved a vote of thanks to the Authors, which was carried with acclamation. He said they might later investigate subjects with which the Society was more closely concerned, and then they might pay the Society a second visit. He also thanked those who had taken part in the discussion.

Mr. R. E. RIX moved a vote of thanks to the retiring President, which was passed with acclamation. It was 33 years since Mr. W. Trevor Johnson joined the Society, but there had been no decline in his enthusiasm and vigour, and the Society appreciated his regular attendance. They thanked him sincerely for all that he had done to further the study of orthodontics and to maintain the dignity of the Society so well during the past year.

Mr. W. TREVOR JOHNSON, in reply, said he had been pleased and proud to have been President during a year which had been so successful for the Society, with such good attendances. He thanked the officers—the Secretary and the Treasurer in particular—and the members for their support.

The induction of the new President, Mr. K. E. Pringle, then followed.

Mr. A. G. TAYLOR proposed a vote of thanks to the retiring Secretary, Mr. Richards, which was passed with acclamation. Mr. Richards had been secretary for six years—six of the

most successful years of the Society's history, during which both membership and attendanee at meetings had increased to record heights. This increased aetivity had thrown extra work on to Mr. Riehards, but it was, in fact due to his wonderful personality and ardent enthusiasm. He had guided the Presidents through their years of offiee and, by his charming smile and exquisite tact, had kept all the officers of the Society up to the mark.

In Mr. Taylor's 20-odd years of membership there had been only three secretaries, Mr. Cutler, Mr. Pringle, and Mr. Riehards; and they had all eome from the same stable. Mr. Riehards was a man of method and would hand over the affairs of the Soeiety in apple-pie order.

Mr. Howell Richards, in reply, said it had been an honour to be Seeretary. It had not been too difficult to be a suecessful seeretary to the Soeiety as the Offieers generally were most eo-operative. The Soeiety should bear in mind, as no doubt it would, that the Secretary's seeretary also did a great deal of work. He had no doubt that Mr. Leech, the new Seeretary, would perform his duties most effieiently.

The meeting then terminated.

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

Balance Sheet and

Income and Expenditure Account

FOR THE YEAR ENDED SEPTEMBER 30, 1954

FREDK. B. SMART & COMPANY, CHARTERED ACCOUNTANTS

22 Queen Street, London, E.C.4.

The British Society for the Study of Orthodontics

BALANCE SHEET as at 30th September, 1954.

1953								
£	s.	d.		£	s.	d.	£	s. d.
			Accumulated Fund:—					
			Balance at 1st October, 1953 ..	1,980	4	3		
			Add Excess of Income over Expenditure for the year	465	9	4		
1,980	4	3					2,445	13 7
			Creditors:—					
1,500	0	0	Transactions—1953 and 1954 (Estimated by Hon. Treasurer) ..	950	0	0		
26	5	0	Northcroft Memorial Lecture ..	26	5	0		
22	10	0	Hire of Hall	27	0	0		
7	17	6	Museum Rent	7	17	6		
11	0	0	Refreshments	12	0	0		
	—		Subscriptions in Advance ..	9	10	10		
6	2	6	Sundry Expenses	1	17	0		
8	8	0	Audit and Accountancy		—			
3	10	0	Subscriptions due for Refund ..		—			
							1,034	10 4
£3,565	17	3					£3,480	3 11

S. B. NEWTON
T. L. WINN } *Hon. Auditors.*
J. S. BERESFORD, *Hon. Treasurer.*

1953								
£	s.	d.		£	s.	d.	£	s. d.
			Furniture and Office Equipment:—					
			Balance at 1st October, 1953 ..	397	9	6		
			Less Depreciation at 5% per annum on Cost	30	11	6		
397	9	6					366	18 0
			Debtors:—					
9	9	0	1954 Subscriptions received after 30th September, 1954				9	9 0
			Investments:—					
375	0	0	500 National Savings Certificates Seventh Issue at Cost	375	0	0		
75	0	0	*Add* Accrued Interest	87	10	0		
				462	10	0		
575	14	0	£691 5s. 10d. 2½% Consolidated Stock at Cost	575	14	0		
			(Approximate Market Value £915)				1,038	4 0
			Cash at Bank:—					
794	9	9	Westminster Bank, Ltd.	693	12	2		
1,338	2	0	Post Office Savings Bank ..	1,370	10	2		
							2,064	2 4
			Cash in Hand:—					
	11	6	Honorary Treasurer		9	10		
	1	6	Honorary Secretary	1	0	9		
							1	10 7
£3,565	17	3					£3,480	3 11

Certified in accordance with the Books and Vouchers of the Society.
We have verified the Investments and Cash at Bank.

FREDK. B. SMART & CO.,
Chartered Accountants,
22, Queen Street,
London, E.C.4.

10*th November*, 1954.

The British Society for the Study of Orthodontics

INCOME AND EXPENDITURE ACCOUNT for the year ended 30th September, 1954.

1953									1953							
£	s.	d.		£	s.	d.	£	s.	d.	£	s.	d.		£	s.	d.
10	10	0	To Museum Rent				10	10	0				By *Members' Subscriptions:*—			
95	3	0	,, Printing and Stationery	83	17	1							1954 Subscriptions	1,108	5	6
473	18	7	,, Reserve for Cost of Transactions	444	1	1							Adjustment in respect of Past Years	48	6	0
							527	18	2	1,071	10	6				1,156	11	6
21	1	8	,, Postage	24	11	10				44	1	0	,, Sale of Transactions			73	8	10
14	15	0	,, Lantern and Film Expenses	3	1	0				12	10	0	,, Accrued Interest on Savings Certificates			12	10	0
45	0	0	,, Hire of Hall	54	0	0				17	5	4	,, Interest on 2½% Consolidated Stock			17	5	4
47	6	10	,, Reporting	51	9	0				20	8	6	,, Interest on Post Office Savings Bank Account			32	8	2
66	0	0	,, Refreshments	67	12	0												
							200	13	10									
8	8	0	,, Audit and Accountancy				8	8	0									
3	8	6	,, Insurance				3	8	6									
11	11	8	,, Library and Journals				8	13	6									
26	5	0	,, Northcroft Memorial Lecture				26	5	0									
10	18	2	,, Sundries and Hire of Equipment				10	6	0									
30	11	6	,, Depreciation on Furniture and Office Equipment				30	11	6									
300	17	5	,, *Excess of Income over Expenditure for the year*				465	9	4									
£1,165	15	4					£1,292	3	10	£1,165	15	4				£1,292	3	10

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